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MY LIFE WITH THE KAGU *Rhynchotus jubatus*

by Dr Henry Quinque

*An English translation by Soazig Le Nen Davy and
Ghislaine Coulon of an extract from Dr Quinque's
forthcoming book Sur la piste des animaux en danger (On
the trail of endangered animals).*

With great love and dedication, I have tried to protect the lives of both human beings and animals in danger of extinction.

The list of species that I have brought up so far in my life is far too long to go into here. So instead I am going to write about one which is particularly special to me at this time.

A large number of species inhabit the Conservatoire Des Animaux en Voie D'Extinction that I have created here at Le Mesnil Aubry in France, in order to save the lives of those unable to survive in the wild. Of these, I would like to introduce to you the Kagu, because of the special feeling I have for it in my heart and also because it figures on the IUCN (International Union for Conservation of Nature and Natural Resources) Red List of the most endangered birds in the world.

I hesitated for many years before deciding to write about it. When one has spent a great deal of one's life close to a human being or animal, or a beautiful art object, one finishes by not seeing it any longer, as it has become an integral part of one's life.

At the beginning of the encounter, it is easy to believe that everything is simple, when in fact, the discovery of the truth often hides a formidable complexity. Quite paradoxically, my initial contact with the Kagu brought about feelings similar to the ones felt, a long time ago, regarding my profession. When I was preparing myself, during my youth, to become a surgeon, I was confronted with what seemed like the insurmountable obstacles of the academic examinations; yet, it was only after overcoming those barriers, that the true professional training could take place.

Then, many of those young recently qualified surgeons, full of themselves,

just after putting the last clamp on their third easy appendectomy, believed themselves to be the equals of their masters. The years that followed brought them back to reality, because the knowledge they had acquired so far from books, was nothing more than a speck of sand in the ocean that remained to be crossed. This limitless ocean is called experience and one will continue to acquire it until the end of his or her professional life. It is only at that time, just as it was 40 years ago, that things will appear once more to be simple, because after they have managed to overcome myriad difficulties and everyday unexpected events, they will, at long last, have become surgeons.

My life followed a similar pattern regarding the Kagu. When I discovered it, I believed I knew everything about it; then I lost track of reality as we were too close to each other and it is only now after a third of a century, that I have started to know it well and it seems to me to be simple again.

During all that time and in spite of the pressure from those close to me, I did not dare publish anything about it, for fear of having too little to say. It was only when I started writing that a wealth of data on my old friend came to me, from both my memory and my notes.

The egg

The egg of a bird is a beautiful art object full of mystery that has the ability to give life from a single cell made of elements coming from each of the parents that conceived it and shared equally in its creation. Its form is harmonious and its beauty is at the same time both fragile and extremely strong. Fragile, because the smallest shock can shatter its shell; strong, because the molecules of calcium that constitute its structure act just like the beams of the most wonderful bridges that man's genius has produced. One knows that it is virtually impossible for a person to crush a hen's egg along its larger axis when applying all the strength in one hand. It carries the mystery our dreams are made of. This beautiful object, which can be broken in a fraction of a second, can carry within it the life of an intelligent parrot, of a hummingbird with wonderful feathers, reminiscent of precious gemstones, or that of a Bar-headed Goose *Anser indicus*, able to fly over the Himalayas.

The Kagu egg is a wonder of nature which carries within it the life of a being, exceptional by its total isolation from other birds, and which is threatened by imminent extinction as the result of both evolution and man. As Edouard Marie wrote: "There is in the Kagu something that is indefinable to such an extent that I have said that this animal does no longer belong to our time, that it seems to have lingered on our planet where it appears to be completely out of touch and very soon it will suffer the same fate as the

Mauritius Dronte" (the Dodo).

As soon as France established itself on New Caledonia in 1853, Edouard Marie was first to write about the Kagu. This Chief Administrator in the French Navy and amateur zoologist wanted to find out about the egg of the Kagu that nobody had yet set eyes upon.

He wrote: "I have heard that somebody in England published a description of the egg of the Kagu, but I believe it is to be taken with a pinch of salt. This discovery is not creditable; I am quite sure of it. I have often asked the locals, in exchange for up to 10 francs per egg, to find me such an egg, but I have, along with many others, been misled, many times; to such an extent that one day what was guaranteed as a Kagu egg turned out to be an egg from the *Herodia albo-lineata* (local heron)."

The Kagu lays only one egg, which is dusky pink in colour and decorated with chocolate brown specks and blotches of varying sizes. Some of these can measure many millimetres in each direction, others can be vermiform (worm-shaped), chiefly on smaller eggs. The marks are denser on the larger end of the egg. Their colour varies, as if they are more or less set within the shell, the brightest ones seeming to be resting on the surface, while the darker ones appear to be embedded deep within the structure of the shell.

We have undertaken a study of 170 eggs. Of that number, 80 weighed between 80g-82g and 22 weighed less than 65g. Therefore, the average weight was 74.18g. Quite often eggs that were lighter were infertile or we encountered hatching difficulties with them. Yet, on three occasions, we obtained viable hatchlings from eggs weighing only 62.5g. The average dimensions of the 170 eggs were 63mm x 50mm.

In order for successful incubation it is important to pay attention to the density of the egg. The density is worked out by dividing the weight by the volume. It provides useful information on the thickness of the shell and its eventual porosity. An egg with a thin shell with numerous pores will be lighter. Its incubation will necessitate an higher level of humidity in order to avoid losing too much weight. With a thicker shell the necessary level of humidity will be lower.

To successfully weigh an egg one needs to use a scale accurate to the centigram. To calculate the volume of an egg, use the following formulae in millimetres:

$$V = \text{length} \times \text{width} \times \text{width} \times \text{width} \times 0.51$$

The coefficient of 0.51 can be applied without any harmful consequences to the calculation of the volume of any egg (and is particularly true in the case of the Kagu egg).

There follows two examples of calculations of density:

Egg No.1. Weight: 81.20g
Size: 62.93 x 48.90
Volume: 76.74
Density: $P/V = 81.20/76.74 = 1.05$

Egg No.2. Weight: 72.43g
Size: 60.95 x 48.11
Volume: 71.94
Density: $P/V = 72.43/71.94 = 1.00$

The last 30 measurements made were within the range $D = 1.00$ - $D = 1.07$, giving an average density of $D = 1.029$. We were keen to check if there was a correlation between the density and the thickness of the shell and found this to be the case; the thinner the shell, the lower the density. The shell of the Kagu egg is on average 0.24mm thick. As a comparison, a hen's egg is on average 0.40mm thick and has a density of 1.06; therefore it is quite superior to that of the Kagu.

Incubation

We have tried various methods of incubation. It may seem simple to leave the egg with the parents or to place it under a hen, but both of these methods have led to failures. The Kagu is not going to change its ancestral and genetic laying habits, whatever the conditions or the season. Birds from a succession of generations brought up in France carry on laying their eggs during the Austral spring and summer, which means that they lay them during the autumn and winter here in Europe.

Our birds quite often lay their eggs at a time of the year when frost is prevalent. They often do so inside the shelters which are heated at an average temperature of 15°C (59°F). When it is really cold outside, the temperature inside the shelters is not sufficient to assure successful hatching. Every time we left the parents to incubate the eggs, the embryos died during periods of heavy frost. We have managed to hatch only three chicks from eggs laid as early as the end of September or as late as the end of April.

Our trial using black silky hens also failed; although these hens are light and calm, they broke the eggs, which have such thin shells. This happened 10 times. Because we would not dream of depriving our birds of their natural, outdoor environment, we have had to settle for artificial incubation. It is obvious that an animal is so much healthier if it can go out into natural wooded undergrowth, enjoy the rain and return to its shelter when it so wishes, rather than being kept indoors behind glass, no matter how pleasing it may be to the human eye.

Sometimes the females lay their eggs outside in a quiet corner, hidden by a bush, among big trees. They make a scrape in the earth, 25cm (approx. 9¾in) in diameter and about 5cm (2in) deep and line it with leaves and blades of grass. Most of the time, however, the eggs are laid inside the shelters. The ground inside is covered with straw and the female collects some of this in a corner and makes a pile some 60cm (2ft) in diameter and 20cm (8in) high, in which she makes a small indentation in the top. It seems that the shelters are preferred because of the pleasant ambient temperature and the dusk-like atmosphere we purposely maintain in them.

After four or five days, the female lays her unique egg. During nest building and the egg laying the male remains close by in order to protect his partner. Under natural conditions, the males undertakes half of the incubation, preferring to sit during the night.

Artificial incubation technique

Soon after it has been laid, the egg is removed. It is always very clean, the only exception being when it is stained with a single drop of blood when it comes from a primiparous female. For the first four hours the egg is stored in a room in which the temperature is controlled at 22°C (71.6°F); then it is disinfected by immersion in an antiseptic solution. It is important to assure that the temperature of the solution is higher than that of the egg, in order to avoid a bacterial transfer to the inside of the egg and, to allow instead, the bacteria to escape; this can be observed as small bubbles of air rising in the solution.

The egg is then laid horizontally in the incubator and is not moved for 48 hours. It seems to us that it would be dangerous to place the egg vertically. To start with, unless there is an indication that the egg has a very unusual density, the incubator is set at a temperature of 37.5°C (99.5°F) and the humidity at 50% in the knowledge that we will have to adjust this at a later date, according to the characteristics of each egg. During incubation we believe it is essential to have a cooler phase to mimic the effect of the bird leaving the nest and for this reason we use an incubator built to our own specification, which allows the temperature to be adjusted at will.

The thickness of the shell and specific porosity of each egg varies; it is therefore essential to plot the loss of weight on a graph. For an incubation period of 34 days or sometimes 35 days we have found that the Kagu egg loses 15% of its initial weight. Using graph paper, we start by tracing the 15% weight loss line, then add a 12% weight loss line and an 18% weight loss line. We know that the weight loss must be between these two extremes and as close as possible to the 15% weight loss line.

It is important to know that the earlier during incubation we act, the

easier it is to rectify the weight of the egg, should this be necessary. After the third week, it is more difficult to achieve a satisfactory result. To increase the weight of the egg we increase the level of humidity, and to make it lose weight we decrease the level of humidity. In the latter case we sometimes have to establish a level of humidity drastically below that of the ambient air. For this purpose we use specialised dehumidifying equipment to decrease the level of humidity in the lab. In all circumstances the temperature in the room must remain at 24°C (75.2°F).

The egg begins to chip after the 30th day. Unless one has experience of this, it is easily missed as it begins as a simple crack that may only be visible if one increases the intensity of the control lamp and cannot always be felt with the fingers. At the same time it is often possible to hear the rubbing sound made by the chick inside the egg. Checking the egg against the light, it is possible to see irregular movement between the air pocket and the bulk of the egg, proving that the perforation of the membrane has begun. At this critical stage it is essential to increase the level of humidity to 80% or even 90% depending on the ambient temperature. If this is not done, there could be rapid dehydration which will result in the chick becoming stuck to the shell membrane.

If everything is normal, the initial small crack will become a discrete star-shape, which will grow bit by bit until it covers three-quarters of the surface of the egg. Shortly afterwards, a piece of shell will fall off, letting us see the chick's beak. We will have to wait for a further two to three days before the chick manages to force its way out through the opening, at the large end of the egg. The back of the chick's body will remain attached to the membrane inside the shell and to a gluey, jelly-like substance, until such time as the small blood vessels which supply blood to the umbilical cord have dried out. This is the time when one must be patient and avoid intervening unnecessarily, while at the same time there is the need to maintain a constant check on the egg, during this extremely dangerous period of the hatching process.

From time to time, the sound of rubbing coming from inside the egg may continue for up to 24 hours without any cracking materialising. If the rhythm diminishes or the sound from inside becomes fainter and, if the movement of the beak is not apparent when the egg is examined under a strong light, then it is imperative to intervene.

Firstly, the larger side of the egg must be disinfected and then an incision made about 3mm in diameter, not forgetting to remove the small flap of shell membrane which could obstruct the air flow. Then, if all goes well, after a few hours of deafening silence, the cracking will restart, but never where the small hole was made. Two or three days later, a very lucky chick

will hatch.

It is essential during the duration of the hatching process to keep an eye on the chick's cardiac rhythm which we do using the Avitronics Buddy Egg Monitor.

When the chick has been removed from the incubator, it is important to clean the incubator thoroughly. We disinfect it while it is still hot, doing so for three days, using trioxymethylene or an iodine solution, then ventilate it thoroughly prior to using it again.

The chick

I must confess my surprise at the hatching of our first chick. It weighed 50g, having hatched from an egg that had weighed 75g. After the effort it had made to emerge from the egg into the outside world, it remained very still. One could not but be surprised by its big head and its large bulging eyes in relation to the size of the rest of its body, which was covered with dark pink coloured skin, that appeared to have black spots or what looked like tufts of hair scattered over it in an irregular pattern.

This tiny living creature, which looks more like a big-headed young rat, than a bird, remains attached to the cord at the bottom of the shell for a further two to four hours. The cord will break when the chick moves, or, it may be necessary to cut it, after first ensuring haemostasis (i.e. the blood supply has been cut-off). The chick is then transferred to a brooder with the humidity set at 50% to allow the chick to dry quickly.

In the course of a few hours, one witnesses a miracle in which this nearly lifeless, ugly creature, turns into a magnificent living jewel. The black spots scattered over the skin have dried and turned into tufts of black down and the chick resembles a dense, silky bubble, with its shiny golden brown skin reminiscent of the colour of autumn leaves (leaves in the fall) in woodland undergrowth. The back is darker brown than the sides and belly, while the overall colour has the shiny look of a chestnut. The chick, which looks three times larger than it did when it emerged from the egg, lies motionless resting on its belly.

The eyes of the liveliest birds are already open wide and are black. It is surprising to note that the eyelids are covered with minute, yellow downy hairs, which are beginning to take on the appearance of eyelashes. There are four little tufts at the front of the top eyelid and two or three towards the back of the lower eyelid. The enormous head measures 4cm (just over 1½in) long, although in fact the skull measures only 1.5cm (just over ½in) long. The body is 10cm (4in) long and 8cm (3in) across.

The beak is black and seen from above appears surprisingly short, because most of the base of the upper mandible is hidden by down. Already

at this early age the beak possesses one of the Kagu's strangest anatomical characteristics; it has nasal operculum (a flap) over each nostril. These shiny black flaps are shaped like a grain of wheat, split along its length. They are 4mm long, 2mm wide and 2mm thick. During the course of the bird's life they will protect the nostrils when the bird is probing or digging in the earth in pursuit of worms and other prey. Seen in profile, the beak is 2cm ($\frac{3}{4}$ in) long and carries on its tip a small, shiny diamond (the egg tooth), which this bird, like others, uses to break through the shell of the egg.

The light coloured down concealing the base of the upper mandible, extends in a strip up to the centre of the skull and sometimes reaches the neck. On the sides of the body there is a clear, S-shaped light coloured strip, which runs from the base of the neck towards the body and then turns back, some 2cm ($\frac{3}{4}$ in) lower, before disappearing behind the legs. This magnificent design provides the chick with extremely efficient camouflage, should it remain motionless in the undergrowth (see photo p. 78).

A strange characteristic we have noticed is the presence of a triangular area of bare skin, which begins at the base of the neck and stretches from the wings to the upper part of the dorsal region. The dorsal vertebrae can be seen protruding beneath the fine, pinkish coloured skin (see photo p. 78). This large triangular area of bare skin later disappears. Within a fortnight, the sides acquire a blue tinge, which on closer examination can be seen to be minute feathers beginning to grow. Two weeks later, the entire area is covered in embryonic feathers still enclosed in their small pipe- or tube-like sheaths. These are the last feathers to grow and after six weeks resemble a dark grey pelerine (cape), covering the back and the adjoining part of the wings.

Behaviour of the newly-hatched chick

The chick is barely able to move for the first two days of its life. At most, it can waddle just a few centimetres (an inch or so). It is only semi-nidifugous. However, between the third day and the sixth day, it makes incredible progress, with the result that this small transient chick develops into a truly nidifugous young bird (ready to leave the nest) and able - beginning by lowering its head and flapping its wings - to trot faster and faster.

To raise a Kagu is a richly rewarding experience, as its emotional state develops rapidly from day one. The development of a baby Kagu is similar to that of a human infant. Because I have got into the habit of removing the eggs towards the end of the incubation period and because I am present at the hatching and, even before the chicks hatch, all treat me with the same affection as they would show towards their biological parents.

On the practical side, each chick is kept in a darkened area heated to 36°C (96.8°F) for the first three days. In order to avoid it slipping, which could happen if it was kept on a smooth surface, it is important that it is kept on a non-slip surface or on fine earth.

From day four, the chick is kept in a wooden box measuring 150cm x 50cm x 50cm (approx. 5ft x 1ft 8in x 1ft 8in), that has a soft light and has earth on the floor. The temperature in the box is progressively reduced to 34°C (93.2°F) and then 32°C (89.6°F). The source of the heat is in one corner, leaving the chick free to choose whether or not it wants to be close to the heat.

When we remove the chick from the box to let it run about on the floor of the room, we have noticed that it behaves strangely. As soon as its feet come into contact with the hard, cold floor (temperature 22°C (71.6°F)), it adopts a specific stance. After a few steps, it stops, half turns or turns completely around, and defecates. This we have found extremely useful in the mornings, both for reasons of hygiene and as a way of keeping the box clean.

Each and every one of the Kagus that have been raised by myself and my wife, have shared in our everyday life. They have been allowed access to our kitchen and the laundry room. This makes a lot of extra work for us in the winter (which is, of course, the time of the year when the young Kagus are growing up here in France) and means, as the chicks grow bigger, cleaning up increasingly larger amounts of droppings. Also, we have to be extremely careful where we are stepping, as an increasing number of times a day, the chicks are let out onto the kitchen floor, in order to exercise and develop their muscles.

Towards the end of the first week, a cardboard box is placed on the floor. The box is opened at the front and the chick quickly appropriates the box as a resting place between outings. It is easy to understand why our movements must take account of the chick's presence, for it can spring out of the box without warning and run along criss-crossing our path and even passing between our feet. In order to avoid accidents, we have to shuffle along the floor and be very watchful where we place our feet.

You can imagine what an impact this has on our lives for five months of the year. Yet, our part in the development of such an exceptional bird and, in helping prevent its disappearance from this world, gives us an immense degree of satisfaction, enough to make us forget the inevitable problems.

I often think of the joy Jean Delacour would feel if he could see the large family of Kagus we have succeeded in creating, thanks to him.

For so long now, our family life has revolved around the baby Kagus, which we treat as so they were our children. They have, by showing complete confidence in us, brought us total happiness.

Having spent such a large part of our lives with the Kagus, we have concluded that they behave not like birds, but like a sophisticated species of mammal. Only the large macaws and cockatoos, particularly the Palm Cockatoo *Probosciger aterrimus*, come close to the Kagu's level of intelligence.

Feeding the chick

We generally feed the chick for the first time 12 hours after it has hatched. At first we feed it every two hours, then every three hours from the second week onwards. Although some naturalists have mentioned finding fragments of fern in the gizzard of one or two adults in the wild, we give the chicks a strictly animal diet, consisting of lean ox heart, earthworms, mealworms with the heads removed, snails and pink baby mice.

The amount of food given at each feed is equivalent to a mealworm. We use a small pair of foam-covered surgical pliers to offer the food to the chick. This allows us to dip the food into water and then coat it with a powdered supplement we have formulated, which has proved to be absolutely essential.

Bit by bit we have managed to perfect the composition of this supplement, which enables us to avoid the numerous failures we experienced earlier (which I will mention later). It consists of one part phosphorus to two parts of easily absorbed calcium, plus some trace elements, water and fat soluble vitamins. The water soluble vitamins are group B vitamins (B₁, B₂, B₆ and B₁₂) and the fat soluble vitamins consist mainly of vitamin D₃, an excess of which is just as dangerous as a deficiency.

For us, it is also important to add to the young Kagus' food some earth mixed with detritus collected from the undergrowth. This is equivalent to what would have been absorbed by birds in the wild. Since the discovery of the Kagu in New Caledonia, we have known that it is very fond of 'bulimes.' These are land snails, the spiral-shaped shells of which it breaks open to get at the flesh. We have observed the adults doing this with European snails; they beat them and, also slugs, violently on the ground and never eat them until they are dead. They tear them to shreds and, by the time they have swallowed the pieces or given them to their chicks, they have become covered in earth.

As a result, we decided to add to the food a small quantity of earth collected from the undergrowth. This is rich both in vegetal and mineral elements which are, we believe, beneficial to the chicks' well being. It results in the excrement being of a much better consistency. It consists of a white part, mainly of uric acid from the kidneys, with more substantial black smears, which first thing in the morning are sometimes furry and smelly and are of intestinal origin.

Growth of the chick

From day three, we have before us a wonderful silky, little ball of life, happy to eat every two hours, sleep, and cover 1m-2m (approx. 3ft-6ft) a day. From day five the chick is able to trot and by the end of the first week is even able to run. Bit by bit it learns to follow us as we slowly move backwards, while talking to it. As well as its ability to move about, which it acquires very quickly, it also begins to take an interest in its surroundings. From day eight, nine or 10, the chick begins to make contact with its environment and all its senses develop very quickly. As soon as it sees us, in order to get our attention, it makes a "chirping" sound, which is rather weak but constant. It follows all our movements and tries to get as close to us as possible, even when it has had plenty to eat and is not looking for food.

Towards day 15, the chick begins pecking at our feet and, when we sit down, it nestles on the top of our shoes. If one rests a hand on the floor, with the palm uppermost, the chick comes and rests its feet on the palm of the hand, without completely getting into it. Similarly, whenever possible it likes to place its feet on our feet and spread its toes on the tops of our shoes. In spite of this quasi-human intimacy, however, this creature which has never known life in the wild or its parents, retains two strong ancestral traits: it will always seek out the shelter of a dark place and will always react instinctively to sudden noise.

Even when very small, the Kagu will expose itself to bright light for only a very short period of time. It always prefers to go off and find shelter in a dark corner. This makes life easier for us, as we know that we will always be able to find it sheltering in a dark spot.

In spite of living amongst humans and having total confidence in them and enjoying the comfort of their home, on hearing even the slightest noise, if it is sudden, but not necessarily violent, will cause the chick to suddenly freeze. Even if it is running along happily, with its wings spread, it will immediately lie flat on the ground with its head stretched out in front of it, and will remain completely motionless. It is an instinctive reaction which must have saved the life of many a Kagu over the past centuries.

It is easy to imagine how, if the chick was in wooded undergrowth, it would remain undetectable to predators. When the noise has stopped, even if it was of very short duration, the chick will remain in a trance-like state for several seconds - this really has to be seen to be believed! If one speaks gently to this apparently lifeless body - for it is breathing extremely slowly - it will resume its activity with the same enthusiasm as before it was interrupted by the noise.

Between the second and third weeks something strange begins to happen - play enters the chick's life. It varies according to the individual personality

of each bird. Some are boisterous extroverts that are very playful, others are quieter and reserved, although just as affectionate. The beginning of playtime is signalled by short, strong, "chirping." The chick thrusts its head forward and jumps on the spot, before beginning to run and crosses the room from one end to the other. Sudden changes of direction often result in it slipping or falling but this does not seem to bother it.

The game that amuses us as much as it seems to amuse them, is one I have never seen performed by any other bird. The chick approaches us, stops and points its beak towards the ground and spreads its wings. Sometimes the wings are held horizontally, but most often, the chick lies on its side with the lower wing half-folded and the top wing fully extended. It begins to spin around on its side and goes on to perform an amazing pirouette and ends by completely flipping its body over its head. Afterwards the chick comes back towards us and looks at us as if to solicit our appreciation of its acrobatic prowess.

From time to time we have two chicks of the same age and try to get them used to living together. It is always difficult to begin with, as the Kagu chick grows up in the wild without any siblings or the company of other chicks. The liveliest chick will often nip the toes of the quieter one, but things usually improve relatively quickly and we have yet to witness any aggressive behaviour. On the contrary, chicks brought up together, accept each other and will live together for many months, even into adulthood, irrespective of their sexes. Once the initial contact has been made, the chicks play together and perform crazy somersaults for their and our amusement.

From the third day of its life the Kagu chick emits very weak sounds, but quite quickly seems to progress to producing a three-syllable call which can be likened to "pi-kiou-kiou," that has become so familiar to us that we have got into the habit of calling "pi-kiou," to attract the attention of newly-hatched chicks and encourage them to take their first feed.

Later on they begin producing a more or less clear sound every five to six seconds, which we believe is used in the wild to locate their parents. The sounds produced by the Kagu, both young and adult, give a good indication as to whether it is in good health, the state of its sex life, illnesses it may suffer from and even its closeness to death. I will write about this in greater detail later.

The beginning and the end of the day are periods of maximum activity. Very young ones, just like human children, sleep on in the morning and at dusk become very active and excitable. They begin to run and jump wildly, "chirping" energetically and, this activity, which we know well and enjoy watching, means it is difficult sometimes to calm them down sufficiently to persuade them to go to sleep at night.

When we place them back in their warm box, they run about in all directions and repeatedly call more intensively than during the day. The “pi-kiou-kiou” becomes louder and sometimes has a nervousness about it. Placing a cupped hand under them, we caress them and gradually switch off the light; they slowly settle down and lie on the floor, as if being brooded by one of their parents. They peck gently at our fingers, stop moving their head and their voice loses its nervousness. Once again they become calm and subdued until eventually they fall asleep.

Adolescence

During the first few weeks of its life a healthy chick changes rapidly in colour, size and morphology and, within six months, will be unrecognisable.

It quickly gains weight, going from 50g to 1,000g, and it is impossible not to be astonished by its rapid growth and the many transformations it has undergone in such a short time.

By the seventh day the chick will have doubled its weight from 50g to 100g. Its head will still be disproportionally large compared to its body. Also, it will still retain its wonderful buff-speckled golden brown colour. The shiny, still black, horny-looking operculum (flaps) protecting the nostrils will have increased in length by a third.

By the end of the second week, the small quills of the large wing feathers will begin to appear and it will be time to fit the chick with a closed identification ring (band). By the time the chick is three weeks of age it will already weigh 300g and its measurements will have increased proportionately. The crest will begin to appear as a protuberance at the back of the occipital bone.

Our chick has now lost its extraordinary initial golden brown colour and taken on a darker hue. The two S-shaped lateral lines are present now only as small irregular spots, which help maintain the chick's camouflage, which is less and less necessary, as it is now capable of fleeing at great speed.

It is at the end of this first stage that the strange, smooth area of bare skin on the back, between the wings, becomes a beautiful convex pelerine (cape) covering the back and the top of the wings.

Although the large chick that I have just described continues to eat a lot, it eats proportionally less than it did when it was younger. It is now an integral part of our family and it comes and nestles close to us at every opportunity. It pecks at our shoes and, if it manages to place one of its feet on our feet, it emits a satisfied “clucking” sound. As soon as we stop, it lies down next to us and we dare not move in case we disturb it. It also loves to play with our shoe laces and with the curtain stops. It is deliriously happy

when it succeeds in hiding beneath my wife's dressing gown when she is sitting at the table and, of course, like two contented parents, we dare not move for fear of disturbing it.

At this age the chicks invent games and their personalities begin to emerge. While some cannot care less about music, others are attracted by it. One of our adult birds is named Mozart, because every time I was playing in the small lounge upstairs, he would climb the 20 stairs at great speed, jumping from one to the next, and settle himself next to me and would not move for as long as I was playing. He was without doubt the biggest fan I ever had. Now he is older and lives outside amongst the undergrowth and family duties have led him to forget his love of music in his youth.

Some of the Kagus we have raised have been less intellectual and more athletic, loving, as I mentioned earlier, to perform somersaults. Two or three proved to be particularly gifted athletes that were able to jump so high that they succeeded in escaping from their enclosures.

At two months old the Kagu is already a teenager weighing nearly 600g and has a 10cm (4in) long crest which will soon reach its back. The iris is still black. The nostrils are now completely covered by the horny-looking operculum (flaps) which are now 15mm (just over ½in) long. Long, straight, hair-like filoplumes grow from the base of the beak. Within a few weeks the tail will begin to grow in earnest and the toes will grow considerably longer. The iris will become a beautiful shade of orange and measure an astonishing 13mm (½in) in diameter.

The bird now has a wingspan of 60cm (almost 2ft) and the body and sides are dark grey in colour, but the back is brown. A few specks of light brown down can still be seen on the head; the crest is dark grey without any trace of brown. The sides of the neck are grey with fine barring like that on the flanks of the male Eurasian Teal *Anas crecca* (and the North American Green-winged Teal *A. carolinensis*). Gone now is any similarity to the chick we watched coming into the world a few weeks earlier.

Later, the body will become light grey, but the bird will have to wait until its third year before it acquires adult plumage; during that time the reddish brown colouring on the back will disappear bit by bit.

Complications and abnormalities

If all goes well we will have a fertile egg weighing 75g, that by the 35th day of incubation, will produce a live chick weighing 50g. Incubation will progress normally and at the time of hatching the egg will weigh 15% less than it did when it was laid. The chick will grow rapidly and be a delight to its parents.

The above is, unfortunately, an idyllic example rather than the norm.

Although I have now kept Kagus for more than 30 years I still know very little about the secrets of their life. Those who are sure of themselves in this field can only have kept Kagus for a short time.

As I will go on to explain, incidents and accidents have been both numerous and varied. Despite a thorough analysis of our mistakes and the resultant changes in our methods, however, we frequently continue to find ourselves confronted by different problems the next time.

In our sample of 170 eggs, 93 were fertile, 77 were infertile or were broken and, with 36 of the eggs, the embryo died during incubation; 34 chicks died during the hatching process and 23 were reared to independence and grew up to become adults capable of reproduction.

In the past few years, our results have improved, but we still do not know all the secrets of success. This is despite the fact that our breeding birds come from many generations of Kagus hatched in captivity and behave normally and have not shown any abnormalities during biological tests. Each pair is housed in an individual enclosure with natural undergrowth and has access to a heated shelter.

Couplings are of short duration, lasting no longer than 12 seconds. We have never witnessed a male forcing itself on a female, as is often the case with domestic poultry. Kagus are monogamous and pairs never fight.

In one instance a male and two females lived in perfect harmony for 20 years in a large enclosure, planted with trees and bushes and provided with a large, comfortable, heated shelter. One of the females laid more often than the other, but often the eggs were broken or abandoned when left with the birds, and lots of the eggs were infertile. In the 20 years we managed to hatch only three chicks. Unfortunately, a few years ago, we lost one of the two females, since when, however, four chicks have been reared. This confirms, we believe, that the Kagu is strictly monogamous and another bird, even if it is well accepted, is likely to deter successful reproduction.

Infertile eggs are, it is not surprising, most frequent among young birds, particularly those laying for the first time. In the case of the adults, the greatest number of infertile eggs are laid during the months of January and February, when the weather is often very cold.

The Kagu is not an ordinary bird and, as I sometimes think is the case with endangered birds, it seems to be approaching the end of its existence on earth.

A few years back, another problem we were confronted with was what we came to refer to as "fifteenth day syndrome." The chick hatched normally after the usual incubation period and appeared to be healthy. During the first two weeks it grew normally and became a magnificent chick that was full of confidence, then one day, while running across the room, it suddenly

collapsed. Although it managed to get back up and eat and drink, its gait remained unsteady and, in spite of all our care, it died one or two days later.

This unfortunate chick had known and loved us but we were unable to keep it alive and it had realised this. The most painful memory we were left with was its cry. It would nestle against our hand and make a weak, but deep sound, that betrayed its anguish. Once we heard this cry for help, we knew that it would die within less than two days.

We did, of course, do everything in our power to prevent these deaths and believe that through trial and error we have finally managed to solve this problem. As the parents were free from infection and parasites, we naturally assumed that the chicks' diet was the cause of the problem. We did a considerable amount of research into this over the course of three breeding seasons. During our research we noticed that the feet of some of the chicks had minor deformities and suspected avitaminosis D, which causes rickets (rickets). We gave intramuscular injections of vitamin D₃ and sometimes saw an improvement and in some case the problem was cured. However, we also had our share of disasters. Because vitamin D₃ is fat soluble, it is far too easy to give an overdose, leading to eventual death from kidney failure or multiple fractures due to decalcification creating cavities in the long bones. We also talked about whether or not they might be suffering from beriberi, which is due to a lack of vitamin B and leads to paralysis. At least, if that had been the case, the treatment would have been less dangerous and there would have been no need to worry about the risk of overdosing them.

It was during that period and the three years of trial and error that it became obvious to us that the problem was due to a vitamin deficiency and we finally developed the diet we are using today.

In nature, as a general rule, animals find all they need to survive. Determining the exact chemical analysis of all the factors would have involved a tremendous amount of work, both in the field and in laboratories and the cost would have been prohibitive. It was for that reason that we decided to experiment and find our own answer to the problem.

After having analysed all of our failures, we made some changes to the way we incubate the eggs and to the diet and now achieve a 40% success rate.

The adult

If the Kagu was standing still and you were watching it from afar, you could be forgiven for mistaking it for a small Grey Heron *Ardea cinera*. It is only when it comes to life and begins moving that you notice that it behaves unlike any other bird. As soon as it begins displaying or dancing,

one cannot help but be reminded of the displays of some of the birds of paradise (Paradisaeidae).

The Kagu is similar in size to a domestic hen. It measures 75cm (approx. 2ft 5in) in length and has an average wingspan of 85cm (approx. 2ft 9in). Its crest and tail each measure 20cm (approx. 8in) long and the Kagu's weight varies from 800g-1,100g (approx. 1lb 12ozs-21bs 6ozs), independent of sex.

One is struck by the sheer elegance of its supple and strong body, with very mobile long legs (the tarsometatarsus is 12cm (approx. 5in) long). Both the head and eyes, the latter with a deep red iris, are very big and contribute to the Kagu's unusual appearance. The eyes are situated at the sides of the head, like those of the Woodcock *Scolopax rusticola*, and give the Kagu exceptional stereoscopic vision, even at dusk. The very powerful reddish orange coloured beak is strong enough to grasp and crush its prey. The upper mandible is convex towards the tip, making the beak look curved. The lower mandible is 70mm (2¾in) long and is straight. The beak has 20mm (1¾in) long, silky, grey-coloured, hair-like, filoplumes growing from the base of the beak, which is covered with a thin layer of skin.

The beak has two notable features which are specific to the Kagu and are not found in any other bird:

The two nostrils are separated from each other by an osteo-membranous septum (a bony membrane).

The second feature that is unique to the Kagu, is the cutaneous operculum (the flap) covering and protecting the nostrils. The operculum is present from the embryonic stage and all the chicks we have examined have had it, even those that have died during the early stages of incubation. The operculum of the adult bird measures 15mm (just over ½in) long and 5mm (almost ¼in) wide and plays a crucial role in the bird's life. When examining skins prepared by a taxidermist, one might think that the operculum is corneous (horny) and hard, whereas it is firm though supple. That of the live bird has the consistency of a thick and substantial layer of skin covering the nostrils and has to be lifted in order to see the nasal openings. As the Kagu spends a great amount of time digging for worms and insects, if it were not for this membrane protecting the nostrils, they would become clogged with earth.

The elegance of the Kagu's legs is enhanced by their deep reddish orange colour, similar to that of the beak. They are covered with horny, round scales, which vary in number from one individual to the next. The three long, supple toes, at the front of the foot have 7mm (¼in) long, strong black nails. Some individuals have a clear, horn coloured nail, which they

keep for many years or sometimes for all their life. The nail on the hind toe varies from one individual to the next. For a bird that never uses its feet to dig or turn over earth, it has surprisingly long nails, unless of course, it did so in the past and this is the reason why it developed them.

The Kagu's body is covered with very soft, pale grey feathering, tinged with blue. The feathers are permeated with a protective powder emanating from the deep, dense down. The Kagu loves to bathe and, when it does so, it leaves behind a continuous thick layer of white powder on the surface of the water.

The ends of the long plume-like crest feathers rest on the bird's back, between the wings. The crest feathers of some older individuals are pure white along most of their width. The Kagu can raise its crest high above its head to form a magnificent, soft, helmet-like crown of feathers, with the longest feathers at the front and then gradually decreasing in length towards the back. When the crest is held in a vertical position, floating elegantly above the head, the wind or a strong breeze can cause it to blow to one side or the other. The bird will bring it down and then raise it again and open it in all its splendour during the nuptial ritual or simply to show emotion or salute a visitor.

The tail, which is often hidden by the wings, is composed of 10 straight feathers. Although extremely mobile, the wings do not allow the Kagu to fly, and its flightlessness gives it much of its personality. When the Kagu spreads its wings, a startling array of colours and patterns are revealed, which it would have been hard to imagine were concealed within the closed wings. The latter are rounded in shape and comprised of 10 large primaries and the same number of secondaries.

Rather than give a complex and boring detailed description of the colours and patterns concealed within the wings, which would be of only secondary interest, I will instead refer readers to the photos on pp. 86 & 87 which show, probably better than a written description could describe, the arrangement of the wing bars, the position of the reddish brown area on the wings and the intricate patterning on the primaries and secondaries.

The drawings in Verreaux and Des Murs (1860), which remind one so much of the wonderful wings of the Sunbittern *Eurypyga helias*, have been the subject of many articles, one of which was published under the title - The mystery of the sex of the Kagu at long last revealed. Its author, a New Zealander, thought he had discovered that Kagus could be sexed depending on whether or not they have clear, more or less continuous bars on the wings. Unfortunately for the author of this research, although I do not doubt his competence in the field and his knowledge of the wildlife of New Caledonia, I can affirm that his observations do not apply to the many birds I have

brought up. To the best of my knowledge, I believe it is safe to say that the Kagu is not sexually dimorphic. The plumage of both sexes is identical and we have even had females that were larger and heavier than their male counterparts. Only by listening carefully to their songs, as demonstrated by Neyrolles, or conducting endoscopic or biogenetic investigations, is it possible to determine their sex.

In his guide to the birds of New Caledonia, Jean Delacour (1966) wrote that the feathers of the back are more or less tinged with brown. The extent of this is dependent on the age of the bird. It is possible to determine the age of a Kagu during the first four years of its life, knowing that it is darker coloured when young. A one year old bird, already almost grey, is browner on the back than a two year old bird. To obtain confirmation of a bird's age, one has to look closely at the length and density of its crest, which does not reach its optimum length until the bird is three or sometimes four years old.

Here in France the moult occurs in May-June and takes about two months to complete. In New Caledonia it occurs in January-February.

Anatomy

The first and best study of the Kagu's anatomy, was that by W. K. Parker (1869). It ran to 20 pages and included two bone studies of great quality. From Parker we learn that the Kagu has 16 vertebrae (birds in general have 16-20), with a large and solid atlas, that is the first vertebrae, on which the skull rests. The skull is very big and the orbits (the eye-sockets) are enormous, even in relation to the size of the skull. On hatching, the chick's gigantic orbits set in its vast skull are not large enough to contain the eyes which protrude like an incredible exophthalmia (an abnormal protusion of the eyeballs). The development of the wing bones is normal, but the toe bones are proportionally thinner than the tarsometatarsus which is, by contrast, thick and strong. The carina (keel on the sternum or breast-bone) is small, but is present nonetheless. Ratites and penguins which are also unable to fly lack a carina.

During some autopsies we have found that although the Kagu possesses wing muscles, these are only modestly-sized, whereas those of the legs are extremely powerful, which is not surprising, if you have seen how well a Kagu can run. The gizzard might be a bit thinner than that of granivorous birds such as the domestic hen, but the Kagu's heart is much bigger than that of a hen of the same weight.

Food

The food of the Kagu is 100% animal in origin. Prey found in the enclosures is normally swallowed along with any earth attached to it. When

a Kagu swallows a worm, the earth and vegetal detritus contained in the worm, obviously also enter the Kagu's digestive system. We therefore add to the chicks' food some clean, fine earth, collected from the undergrowth.

The animal origin of the Kagu's diet was confirmed by R. Cadat (1996), a vet working in New Caledonia, who studied the excrement of Kagus and found that their food intake is made up of arthropods, ants' eggs, scolopendrids and myriapods (which prove toxic to other animals), land and water gastropods (the latter taken from along the edges of small streams in the forest), reptiles such as lizards and geckos, earthworms and small 2mm-3mm stones, mixed with fine earth. These represented 50% of the dry weight present in the excrement. 'Bulimes', the snails with a hard shell, which were greatly appreciated by Kagus in the nineteenth century at the time of Edouard Marie, were not among the food consumed by present day Kagus. Perhaps these gastropods were far more plentiful in the nineteenth century.

Our birds have a marked predilection for earthworms, slugs, snails and spiders. Pink mice are given to them as a treat. Be it mice, slugs or snails, prey is always killed and carefully smashed with the beak and rammed into the earth, some of which adheres to the prey. The most practical food for the number of birds we have is lean beef heart cut into strips the size of earthworms. These are mixed with fine earth collected from the undergrowth and are systematically sprinkled with the same powdered supplement we add to the chicks' food.

We vary the menu by occasionally giving them mealworms and small fish and, from time to time, also give them saltwater shrimps. Some long-standing friends from New Caledonia told us that Kagus travel along streams in which they may find freshwater crustaceans. After seeing such streams in New Caledonia, I am not sure that Kagus would be able to catch this type of food, that they appreciate so much. Contrary to what we were told by local people, our Kagus not only like to swim but also like to drink water. Drinking water is essential for the chicks and we provide them with a dish of water from the first few days of their life.

We were told that in the wild, Kagus can lose as much as 200g - 20% of their body weight - if they do not get enough food during the incubation period. In captivity they face the opposite danger, that of obesity. One needs to keep a careful eye on those individuals that eat too much and show visible signs of becoming fat, which is most evident if you spread their wings open.

The search for food

Their captive diet (which we provide for them in glass containers) does not provide any valuable data, so instead I am going to describe how Kagus

behave when searching for food. This they do from dawn to dusk and find most of their prey on the ground in the shade of the undergrowth and never in full sun. The Kagu is an intelligent bird and uses a method similar to that used by a gun dog; one that has stopped and is stationary, never one that is running. The Kagu regularly patrols its territory, varying its speed of movement over 1m-3m (approx. 3ft-10ft), then stopping all of a sudden and looking intently. If it cannot see anything, it will move leaves, twigs and even branches weighing several hundred grammes (500g = just over 1lb). It uses only its powerful beak to do this, never its feet and legs.

It stops and stands motionless like a statue, with one foot on the ground and the other leg at an angle of forty-five degrees and with the toes of the foot clenched. It is like the pose adopted by a gun dog that has found game. Thanks to the position of the Kagu's eyes, which enable it to judge precisely relief and distance, it looks straight ahead. With the prey within striking distance, it will often wait for a few minutes, no doubt to ascertain whether or not it is an earthworm about to emerge from among the leaves and grass - if only by a few millimetres - then all of a sudden, it will plunge its beak earthwards and seize its prey. If a worm becomes stuck in a hole, it may pull on it for a minute or two or in exceptional circumstances may break it into two, doing so in order not to overtire itself. If the worm puts up too much resistance, it may let go of it and wait to catch it on the surface, striking as quick as a flash and giving it no chance to escape. If a worm breaks or manages to escape and retreats back underground, the Kagu immediately plunges its beak into the ground and removes a clod of earth and, if necessary, a second clod of earth, in order to reach it.

We have never seen a Kagu swallow live prey. As might be imagined, after such a lengthy struggle the worm is usually dead.

Behaviour

The Kagu is a quiet and retiring bird, except at dawn when it sings. It lives in the undergrowth beneath the canopy of tall trees and avoids full light, never standing out in the sun, except when drying its plumage after bathing.

Its activity is entirely confined to the hours of daylight. It sleeps from dusk until dawn, sometimes roosting on the ground, but more often perched on a stout branch, a tree trunk lying on the ground or a large boulder. It never roosts more than 0.8m -1m (approx. 2ft 8in-3ft 3in) above the ground and on waking in the morning jumps back down onto the ground, spreading its wings to soften its landing.

It wakes as soon as there is enough light to distinguish the shapes of the trees. Here in France it is awake at about the same time or slightly before

the Blackbird *Turdus merula* begins to sing in the spring and summer. The Kagu's first activity of the day is to sing. The song is so strange and specific that I will describe it more fully later.

The Kagu is monogamous and remains with the same mate for life. If one of them dies, the survivor, at least in captivity, is observed to be having a difficult time. It does not move about any more, sometimes going without food for many days, hiding in a corner of its enclosure or sometimes even inside the shelter.

Trying to introduce a new mate at such a time is not advisable, as the widowed bird may be attacked by the newcomer or even show itself to have murderous tendencies. A month or two later, one can consider introducing a new mate, but never directly into the same enclosure. The two birds must be separated by a wire fence for at least two or three weeks, as they may not accept each other and prefer instead to make their own choice of a new mate. Because the Kagu is an intelligent bird capable of having feelings, the pairing must be made very carefully.

When a compatible pair has been formed, one must wait sometimes for months before a breeding attempt is made and mating takes place and often, much longer, before an egg is laid. The first pair we received was here for many years before the first chick was produced. One must bear in mind that the move from one hemisphere to the other and the complete change of lifestyle are bound to have an influence on this.

A great proportion of the day is spent looking for food. Most of the time, the pair stay close to each other, moving slowly forward 2m-3m (approx. 6ft 6in-9ft 9in) and closely observing their surroundings. Then, suddenly, one of the birds will seize a worm. Periods in between are dedicated to preening and titivating their plumage. Each of the pair will settle in a rather shaded and quiet spot and carefully preen each of its feathers, which (rather like an heron) it then covers in the white powder with which the Kagu's down is saturated.

From time to time during the day there are periods of excitement which, in captivity, may be due to the need for physical exercise or the search for extra food - perhaps something it especially likes. The bird begins running at such a speed that a man cannot keep up with it and then, in an instant, it freezes and stands looking like a magnificent statue or a gun dog pointing. It stands on one leg with the other leg semi-flexed and with the toes delicately resting on the ground on their dorsal surface. The bird may hold this pose for many minutes before resuming its run or acrobatically capturing a worm or an insect visible only to the Kagu.

Whenever a Kagu meets a stranger or is confronted by an unusual object, or if its usual keeper has changed his or her clothes or especially his or her

shoes, it strikes a peculiar stance. The body is drawn up vertically, so that the bird is standing up very straight and its body is in line with its legs. The head is bent forward and the beak is tucked into the feathers of the chest and the wings are held slightly away from the body and together with the tail, which is of similar length, like a wonderful crinoline (worn by women, especially in the mid-nineteenth century) envelope the entire bird. To add to this spectacle, this wonder of nature sports a luminous white satin crest, like a crown, and has wide open garnet coloured eyes.

After a long period of time standing on the same spot, flicking its crest up and down, the Kagu begins to circle around its mate, an enemy or visitor who has come to see it. This is frequently witnessed at dawn before the birds begin to sing. For many years we could look out of a window at the front of our house and watch a wonderful pair doing this. One of them would stand on a stone bench, set in the small wood in which they lived, and the other bird would circle slowly around the bench with regular and measured steps, before eventually breaking into song. Either the male or female may behave in this way. Also, either the male or female may direct such a performance towards me or my wife. We call it the 'caped stance.'

In most cases pairs live happily alongside each other in their individual enclosures. We rarely witness fights between birds which have somehow managed to get over the fence that was separating them. It does though pose an immediate threat. The opponents adopt the 'caped stance,' with their crests raised, and emit a deep "growl" and begin circling slowly around each other, before suddenly going on the attack, with the crest folded flat against the back. The weakest bird will try to escape from its opponent by running away or may lie flat on the ground and remain very still, then at the first opportunity, make off and hide behind a tree trunk, a boulder or in a hole. Even if it manages to hide only its head, this is usually enough to quieten things down. However, this is not always the case and we have had some deaths. Most often the one in greatest danger of losing its life is the trespasser, but this is by no means always the case.

Mating is proceeded by a simple rite. The male stands in a vertical position, with his wings swept back in a crinoline shape, as if for a grand parade, and with his crest flat against his head and back. The female flattens herself on the ground, with her wings spread out and the male climbs onto her back. This never takes on the violent character associated with domestic poultry.

Overall, the most wonderful and fascinating part of the Kagu's behaviour is its dance. A happy and confident bird will come running towards us and spread its wings to reveal their striking black, white and reddish brown colours and patterns. The large wings are supple, round and very mobile

and the bird can move them either in an symmetrical fashion or totally independent of each other, stretching one in the air at an angle perhaps and the other downward, yet always in unity and with grace (see photos pp. 86 & 87).

We have also noticed this behaviour when a bird is excited by the sight of a mouse which is about to be offered to it as a treat, and on the rare occasions when a bird attacks a person because it does not like the colour of their shoes. It will attack their feet and grasp one of them in its beak and hold it in a vice-like grip, refusing to let go, and will spread its magnificent wings and place them flat on the ground. It is likely that when the owner removes their shoe, they will find that they have been left with a bruise as a souvenir.

Although a Kagu hatched in captivity enjoys human contact, it more often prefers the company of its own kind. A bird brought up in our home and released into a semi-wild woodland habitat will, for many months, continue to come back to us for food, even though it has for a while been feeding itself. The young, but already large, blackish bird will lie on the ground, nod gently and then move its head back and bring its nictitating membrane (the third or inner eyelid) across its eyes, giving them a bluish tint. If we offer the young bird some food, it will take it and give a cry of joy. This stops, however, as soon as it reaches adulthood.

Occasionally, a Kagu will climb up onto someone's lap so that it can be stroked. However, only the most affectionate and confiding birds will do this.

The song

Every morning at dawn for the past 30 years, I have waited full of emotion for the song of the Kagu to announce that yet another day is about to begin and life is about to blossom once more for the creatures of this planet. If I happen to be away from home, I miss the song immensely. It is a song that dates back to the origin of the world and is so different to any other song that one might hear or imagine.

There is no evidence that it is directly related to sexual activity, as the song varies very little from one period of the year to the next. It seems more likely that it is linked to the defence of territory, be it that of a single bird or a pair.

Various data has been recorded on the song of the Kagu in the wild in New Caledonia, however, not all of it matches up with the song we are familiar with. Therefore, I will confine myself to describing the song we have heard personally over many years here in France.

A great number of animals, all of which are paired, live here on a few

hectares (1 hectare = 2.4 acres) near Paris. As soon as the first hesitant light of day subdues the intensity of the night, one of our oldest males seems to believe that his song can make the sun rise. If this was the case, at least he would have the advantage over Chanteclerc (or Chanticleer: the rooster in Chaucer's *The Canterbury Tales*), for he began singing many centuries before it.

A few minutes before dawn, the first male comes forward and lets us know he is ready to sing. He produces a series of very soft and deep notes, all of which are similar and which I would describe as "ko-ko-ko..." This prelude lasts about 30 seconds and builds into a crescendo, increasing in tempo at the same time as its tessitura (pitch) becomes higher and higher. Following an even sharper note, the singer stops for two to three seconds, before launching into its full musical score. The song of this endangered species is both magnificent and moving and unlike that of any other bird. Some might compare it to the "yelping" of a puppy, but to us the song of the Kagu is harmonious, resonant and modulated; its inflected tempo is accompanied by harmonics pleasing to the human ear. Constituting the basis of the score is what could be described as a repeated "wah-wah-wah..."

Most of the time the song is made up of 12 notes and the rhythm can be described as follows:

1 2-3-4 5-6-7 8-9 10-11-12

Musically speaking, the first note is an isolated white note, followed by two triplets (three beat rhythms), a semiquaver and then a third triplet. Between the last semiquaver and triplet, the pause is shorter than that between the preceding group of notes. Also, the last notes are higher and louder than the first ones. It is very important to note (and I will explain why) each bird is capable of singing different variations of the original 12 note score.

There are three other rhythms which are most often used. The theme can be based on 11, 13 or 14 notes. In order to compare the possible rhythms, one can use the following table:

1	2-3-4	5-6-7	8-9	11 notes
1	2-3-4-5	6-7-8	11-12-13	13 notes
1	2-3-4	5-6-7	10-11-12-13-14	14 notes

So, contrary to a common belief, the song of the Kagu is not immutable, but is variable. Not only may it vary from one bird to the next, but also the song of the same bird may vary from one day to the next and, sometimes, even during the same recital. This can have important consequences when one is trying to estimate the number of birds living in the wild, for this bird which remains nearly invisible among the undergrowth, can only be counted by listening carefully to its song.



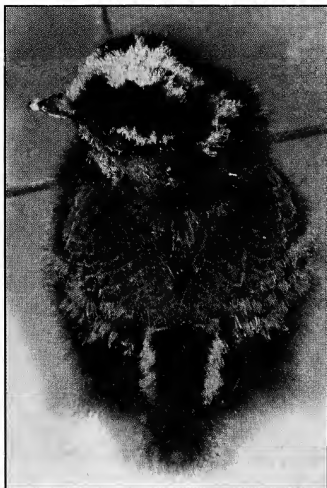
The Kagu lays only one egg.



Our first Kagu chick.



One week old.



Ten days old.

The advantage we have over those working in the field, who have the difficult task of recording the number of birds singing in the wild, is that we are able to observe which of our birds are singing. After having listened to one bird changing the notes of its song from one day to the next, it is easy to imagine the high probability of census results being incorrect, if they are based on the principle of each bird having one immutable song. A Kagu changing the rhythm of its song from one day to the next, might easily run the risk of being counted more than once. On the other hand, the song of the female is very different and does not vary so much. The female of a pair never sings first, but always follows the male.

As the male prepares his prelude, an increasing "ko-ko...ko-ko," the female quickly draws closer to him, so that they are touching wing to wing. Most often the pair climb onto a stump or stand on a flat boulder that is not too high; sometimes one of them is perched while the other remains on the ground and, with its wings held in a funnel-shape along its body, circles around its mate.

The head is held in an horizontal position, with the beak pointing slightly downwards. The crest is never erect when the bird is singing, but instead lies flat against the back. As the male reaches the end of his musical verse, the female joins in. Her song is faster, more agitated and shorter than the male's, and is limited to six notes. She sings: "wah-wah-wah-wah-wah-wah," but in a much higher tessitura (pitch), giving the impression of a duet between a soprano and a baritone. As the female is generally singing faster than the male, she catches up with him bit by bit and, after two repeats of the same verse, the male and female are singing together.

The song carries for hundreds of metres (yards) and is a familiar sound in our village. Thankfully, I guess that it is due to its great originality we have not, so far, received any complaints from the villagers.

Yet, when a large number of Kagus sing in chorus, one is happy to hear them and one is quite definitely wide awake! A pair will carry on for three to five minutes and then stop all of a sudden. The male takes the decision when to stop, in the same way that he decides when to begin. The female never sings alone. As soon as the first pair begin singing, the others quickly join in for a grandiose and noisy chorus which can be heard up to 1 km (almost 1 mile) away. Then the chorus is gradually brought to a close in the same sequence as it began.

If one has a trained ear, it is almost impossible to mix-up the male and female voices which, to date, remain the only practical means, if fleetingly, of sexually identifying these identical looking birds.

As well as its unique and surprising song, inherent to this bird and no other, an odd link in the chain of life, the Kagu emits various other sounds

according to the circumstances it finds itself in.

Whilst still in the egg, before the first break in the shell has appeared, faint calls can sometimes be heard coming from inside. One needs to pay close attention to these, especially if they become increasingly frequent yet diminish in intensity. The chick may be in danger of dying and these are cries for help. If no break in the shell appears, one must rapidly pierce the air pocket to save the chick which, because it is wrongly positioned or is too weak, is unable to break the shell.

After lying motionless for a few hours following its hatching, the chick begins to emit very brief, weak cries, which are, nevertheless, clearly audible. After the first week, this single note cry changes to a repetitive "pi-kiou-kiou," which we are so familiar with. After the third week, many of the young birds produce a low but more or less clear single note call every five to six seconds, which we believe is their means of maintaining contact with their parents.

Having reached more than two months of age and having been feeding itself for more than a month, the by now well grown chick continues from time to time to beg for food as it did when it was a baby, and makes a deep sound conveying satisfaction. It is at about six to eight months of age that the teenager first attempts to imitate the song of the adults. It produces three or four very amusing notes in a hoarse and falsetto voice, that are irregular both in rhythm and tonality and have but a distant link with the beautiful hymn sung by the parents, which the teenager will take at least two years to master.

Fights can occur if one bird enters a neighbour's territory and when this happens the Kagu emits a brief, very loud, piercing, panicky cry, which alerts us to its plight and the urgent need to intervene to prevent murder or serious injury.

Both the male and female produce exactly the same deep musical sound which is typically associated with human contact. They produce this very distinctive sound when we get close to them. They raise their crest so that it is in a vertical position and encourage us to pet them by emitting a rumbling sound consisting of soft, deep modulations from the rhythm of the main song, but of only up to 10 notes, which is pleasant to the ear and not dissimilar to the "purring" of a cat.

Biology and pathology

Some biological research has begun in New Caledonia, however, it is fragmented and of little significance. It has been stated, for example, that the Kagu has three times fewer red blood cells than other birds, but that the haemoglobin concentration is three times higher. Others have found that the



The chick's cryptic coloration enables it to blend in with the dead leaves and other debris on the forest floor.



The strange area of bare skin described on p.56. The dorsal vertebrae can be seen protruding beneath the pinkish coloured skin.



Aged three weeks.



A chick aged two weeks old and a young bird aged two months old.

biological make-up of the Kagu is similar to that of other birds.

Analysis of the faeces has highlighted the presence of parasite eggs, which is a common occurrence in birds. You may be interested to know that in 1988, Mrs J. Petter and her colleagues isolated a nematode which seems to be specific to the Kagu, therefore they named it *Cagourakis dorsalata*. It is a Heterakidae living in the caecum (the blind end of the first part of the large intestine) of the bird and, whose eggs, formed of one or two cells, are characterised by a thick peripheral membrane. This parasite was present in all of the recently weaned birds examined at the zoological gardens and at the Rivière Bleue park in New Caledonia, and seems to multiply greatly during the hot and rainy season. There seems to be no firm evidence whether or not such a parasite is potentially dangerous to the birds.

Parasitologists believe that *Cagourakis dorsalata* may be similar to *Heterakis gracicauda*, another Heterakidae, adapted in the same specific way to the kiwis *Apteryx* spp. of New Zealand. We have never detected the presence of *Cagourakis dorsalata* in our birds, but have lost a Kagu due to coccidiosis (a disease caused by a microscopic, spore forming, single-celled parasite that infects the intestinal tract of animals and humans), but managed to treat and save another.

The list of diseases affecting adult Kagus seems rather short compared to that affecting most other birds and is a major contributory factor to the Kagu's longevity, which is in the order of 25-30 years. One of our birds lived over 30 years.

Occasionally we have to deal with infectious conjunctivitis. Only once in a particularly severe case did a heavy discharge of pus fail to respond to a high dose of antibiotic, which led to blindness followed by death a few months later. We also have had a female Kagu with a full-blown case of abdominal cancer.

The main health concern affecting our birds, however, is caused by them over-eating. Kagus can become obese, with their weight increasing by hundreds of grammes (400g = approx. 14ozs or almost 1lb) and a thick layer of fat developing all over their bodies. To reduce this threat to their health we have eliminated fat from their diet and reduced the amount of food they eat. We have also increased the number of food distribution points, to help ensure that amongst groups of juveniles the weaker birds get sufficient food and the strongest and greediest of them do not eat so much.

New Caledonia: home of the Kagu

In order to better understand the geographical isolation of the Kagu on a global scale and the danger this poses to its survival, it is important to know about its native land.

New Caledonia is an island approximately 400km (250 miles) long and 40km-50km (approx. 25 miles-30 miles) wide, just north of the Tropic of Capricorn, in the South Pacific. It is 1,500km (approx. 930 miles) from the east coast of Australia (Queensland) and 2,000km (approx. 1,200 miles) from New Zealand.

It is almost on the other side of the earth from France, which is 20,000km (approx. 12,000 miles) away, making it France's most distant overseas territory. The main island is named Grande Terre (large island) in the local vernacular. There are many nearby small islands, among them the Loyalty Islands, which are to the east of the Grande Terre. New Caledonia is surrounded by the world's largest enclosed lagoon, stretching over 1,600km (approx. 1,000 miles) .

The island was named New Caledonia by Captain Cook, because the terrain reminded him of the highlands of Scotland.

Geological origin

More than 250 million years ago a massive monolithic supercontinent Gondwana or Gondwanaland, comprising chiefly what is now Africa, South America, Australia, Antarctica and the Indian subcontinent, began breaking up as the earth became warmer. For at least 180 million years New Caledonia has been moving away from Australia and was doing so even before the latter became separated from the main landmass. This is why there are no marsupials on New Caledonia and no placental mammals in Australia.

New Caledonia is situated east of Wallace's Line beyond which, generally speaking, there are no mammals.

Physical geography

The entire length of New Caledonia is lifted by a central mountain ridge rising to just over 1,600m (approx. 5,250ft), with Mount Panié 1,629m (approx. 5,350ft) in the north and Mount Humboldt 1,618m (approx. 5,300ft) in the south. As well as harbouring the wealth of New Caledonia, this mountain ridge also represents a major threat to the Kagu. It holds rich deposits of nickel, a wonderful green rock, for which New Caledonia holds 40% of the world reserve. It is the mining of this mineral which is, bit by bit, depriving the Kagu of its chosen habitat.

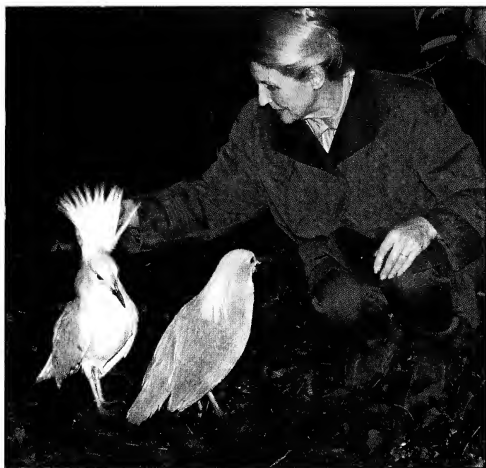
West of the mountain ridge is savannah, home of a tree called the Niaoulis which is harvested for Gomenol (a patented product derived from an essence extracted from the leaves of these trees and mixed with oil and used as a medicine against respiratory infections), the same land is also subjected to intensive cattle farming. The east coast, which is larger than the west coast, is essentially tropical.



A sumptuous pair of Kagus.



The horny-looking nasal operculum of the adult Kagu.



Lily Quinke greets two friends.



Adult Kagu.

The pleasant climate

The entire territory benefits from the influence of the trade winds, but also experiences regional and seasonal climatic differences.

There are two distinct seasons: the hot and humid season from December-March and the cooler and drier season from June-August. If you were to visit the country, I would advise you to do so during what the local people call the "beautiful season", which is from mid-September-mid-November. The average annual temperature is 23°C (73.4°F), but it can rise to 28°C (82.4°F) or fall to 17°C (62.6°F). During cyclones we registered a peak of 33°C (91.4°F) and have been there during the cool or cold season, when sometimes the temperature drops to 0°C (32°F) and occasionally there is frost on the mountain summits.

The average humidity is 80%; it never exceeds 90%. The average rainfall is 2,500ml on the east coast and 1,200ml on the west coast.

Flora

The extremely rich flora is mainly endemic to New Caledonia. Three flora zones exist in the Pacific, of which New Caledonia has one to itself, with 3,000 species having been identified, 80% of which are endemic.

The high altitude humid forest is often shrouded in mist and cloud. The trees are smaller and gnarled and often covered with epiphytes and orchids. Conifers and ferns are also present. The mid-range humid forest, up to an altitude of 1,000m (approx. 3,300ft), is dominated by an incredibly wide variety of very tall palms and tree ferns. To complete the picture, at low altitude the vegetation is sparse, with sclerophyll forest (species with succulent and glossy leaves adapted to drought conditions) as well as mimosas and the all important Gaïac (tree of life), whose wood is so hard that it was used to make pulleys for the great sailing ships. It is this type of forest that has suffered most from irresponsible burning.

One of the last sclerophyll or Gaïac forests has been protected and restored to its original state, thanks to the work and perseverance of a close friend of mine, the engineer Emile Audet. It is the wonderful Ouentoro Park, a joy which tourists can discover on foot, on the outskirts of the capital Noumea.

Fauna

Separated from Australia before the appearance of marsupials and due to the fact that Australia itself was separated from the African continent before the appearance of placental mammals, New Caledonia had no mammals of its own. Thanks to their ability to fly, however, flying mammals, such as fruit bats or flying foxes, the most widespread being the Red Fruit Bat or

Flying Fox *Pteropus ornatus*, and insectivorous bats, must have succeeded in reaching the island at the end of the Quaternary period - before the arrival of man.

If further proof was needed that New Caledonia was once part of Gondwana or Gondwanaland, it is the presence in its waters of *Galaxias* fish, normally found only as fossils in the rest of the world. From the beginning of time, New Caledonia has always been a paradise for birds. Jean Delacour (1966) recorded 110 species that are native to New Caledonia, of which 20 are endemic, which is, when compared to all other countries put together, an extraordinarily high percentage.

Of the 20 endemic species, only one - our friend the Kagu - is the sole representative of its family (Rhynochetidae), a family which was created specifically for it. The Kagu has lived on New Caledonia for millions of years. Previously regarded as having become extinct sometime in the last century, the New Caledonian Rail *Gallirallus lafresnayanus* (described by Verreaux in 1904) is now officially classified as Critically Endangered (Hirschfeld, 2008), on the grounds that there are recent indications that it may still survive on New Caledonia. Many of the rails of the genus *Gallirallus* became flightless, particularly those living on Pacific islands, and suffered population crashes following the arrival of Europeans; some became extinct. The Guam Rail *G. owstoni* is extinct in the wild but a captive-breeding population survives.

Habitat

Apart from rare moments when it seeks out the heat of the sun to help dry its plumage after rain or after having bathed, the Kagu is from birth naturally drawn to darker areas, where it spends most of its time looking for food. It is evident that the Kagu is used to seeking its prey by sight and that this is easier for it to do on wet, soft ground, with a minimum of vegetation. Although it is able to move dead leaves and branches with its beak, it much prefers bare ground on which it is easier for it to spot a worm cast, a caterpillar or a spider. It particularly likes the cover of tall trees, beneath which the ground is bare or has only sparse vegetation. When looking for food, the Kagu walks around dense vegetation rather than trying to make its way through it.

In captivity, our birds live in pairs in separate enclosures and never stray far from one another, though obviously from time to time they lose sight of each other. Observations made in the wild, support our conclusion that Kagus prefer to live in forest with a high, dense tree canopy. They also go into scrubland, but seldom enter dense bush. The maximum altitude at which they are found is 1,000m (approx. 3,000ft). When it rains they tend



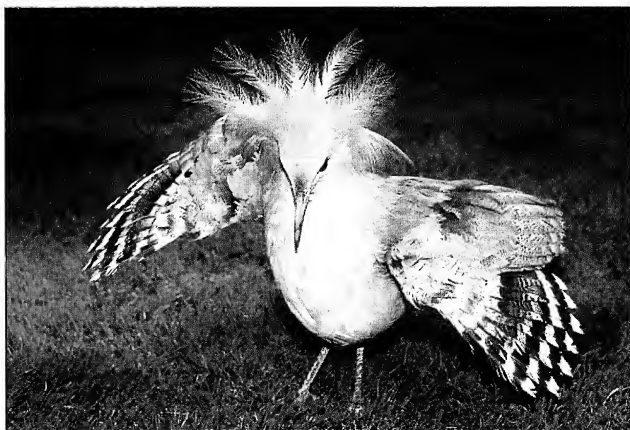
The Kagu walks with measured steps.



The wings are supple and very mobile and the bird can move them totally independent of each other.



The most wonderful part of the Kagu's behaviour is its dance. It comes running towards us and spreads its wings to reveal their striking colours and patterns.



It would have been hard to imagine that such colours and patterns were concealed within the closed wings.

to concentrate on sloping ground, as the run off carries loose vegetation and other debris down to the bottom of the slope, leaving the higher ground clear for them to hunt on. In times of drought, they seek out large forests on level ground, where there is more food available than on the dry slopes.

Some local observers believe that the Kagu may require a hunting territory of 20 hectares-30 hectares (approx. 50 acres-75 acres), when food is fairly abundant. Territorial limits may be imposed on them by barriers of dense vegetation and/or steep slopes created by mining machinery. Sometimes in quieter areas, which are rarer, a pair's territory may be limited by the presence of a neighbouring pair; the border to the territory is then established by song.

Dangers threatening the Kagu

The Kagu has one major predator - man.

We have seen that the Kagu was a trusting creature used to living, once upon a time, on an island free of predators: there were no carnivores or venomous or dangerous constricting snakes. It could happily move about freely, using its beautifully marked wings only for display and not to fly, as it had no need to do so, as it never came under attack and therefore had no need to protect itself. Then humans arrived, first Melanesians and then Europeans. With them came hunting, we could even say that war was waged against the Kagu and all the other animals living in this paradise.

It is said that less harm was caused in the days of the Melanesians, as they did not have guns or dogs. My personal opinion is that their primitive form of hunting was just as devastating for the Kagu population as the noisier and more advanced and sophisticated hunting that followed.

To make matters worse, according to the first European inhabitants, the flesh of the Kagu tasted better than that of guineafowl *Numida meleagris* and the Woodcock. This, of course, had tragic consequences for the Kagu, following the arrival of the first humans.

The Melanesians used to hunt using sticks and slings, and used the latter with fatal precision. The arrival of Europeans with dogs and guns increased the number killed, but in a less significant way than one might imagine, for the good reason that Kagus were becoming scarce and probably more wary as a result of hunting.

Nowadays, although hunting is forbidden by law, the Parc Zoologique et Forestier (zoological and botanical gardens) has often cared for Kagus wounded by lead shot. In an exception to the above law, on four weekends per year, the Notou or New Caledonian Imperial Pigeon *Ducula goliath* may be hunted. A few years back, the *National Geographic* magazine published a photo of a Kanak carrying a gun, who had two beautiful silky

grey pigeons hanging from his belt. It is sad to realise that the French-Kanak administration has not yet got around to recruiting gamekeepers or wardens to monitor criminal activities such as the hunting of Kagus. In 1976, this may have prevented many mining prospectors from boasting that, to supplement their diet, they regularly ate Kagus.

As a general rule, most men are ill informed and are destructive to wildlife.

Shortly after the arrival of the French, the geologist Jules Garnier, who gave his name to garnierite (a green amorphous mineral consisting of hydrated nickel magnesium silicate: a source of nickel), wrote that there were no Kagus to be seen around Melanesian settlements. More recently, Thiollay said much the same, but this time extended his comments to include European settlements.

Going hand in hand with the devastating hunting, we must not forget the impact on the dwindling population of the capture of live birds. In 1977, a partial attempted *in situ* census, discovered 92 birds being held in captivity. A further check in 1984, revealed that only 46 birds remained.

Due to their rarity, Kagus have been taken from the wild for scientific studies and breeding in zoological gardens, which is something I will go into more fully later. Far less honourable and acceptable was the attitude of Japanese seamen working on cargo boats carrying garnierite, who used to lay traps and often forgot about them or left them set between trips. These were often found later with Kagu skeletons in them.

Predatory animals introduced by humans

There are a number of introduced predatory animals that present varying degrees of danger to the native fauna of New Caledonia.

In the old days, there was only one small species of rat, the Pacific Rat *Rattus exulans*. Then boats brought two European species: the Brown or Common Rat *R. norvegicus* and the Black or Ship Rat *R. rattus*. These remain close to human settlements where they are pests and, of course, are also capable of eating Kagu eggs and small chicks; however, one rarely encounters them in the mountainous areas in which the surviving Kagus have taken refuge.

Feral pigs are numerous and occupy all habitats. They can devour eggs, chicks and even roosting adults, but mostly compete with the Kagu for food, eating insects and invertebrates, etc. Adding insult to injury, they also damage the ground to a considerable depth, thus affecting the flora.

Last, but by no means least, cats and dogs complete the list of dangers. A hungry female feral cat, with a litter to feed, can kill an adult Kagu without too much difficulty. The number of dogs on New Caledonia has reached

plague proportions. Those working with hunters can at any moment, while sniffing out game, catch a Kagu. Some of these hunting dogs escape and turn feral and form themselves into killer packs. In 1993, on the Ningua peak, 21 Kagus - that is to say, an important part of the population in an area offering choice habitat for these birds - were killed and eaten by feral dogs. Amongst those that were killed, 17 of them were fitted with radio-tracking devices, which proves the danger these pose and the need to improve them and make them lighter.

Man is also responsible for an array of other dangers that threaten the Kagu.

Fire, mining and logging

In New Caledonia we have witnessed the same dramas that occur regularly in Africa and elsewhere. In order to clear perhaps 2,000sq m (some 21,500sq ft) of land for cultivation, a fire is lit which quickly gets out of control and destroys everything in its path. A particularly bad fire completely destroyed a large farming business in an area of tribal unrest. Undoubtedly fire and the ensuing devastation it causes is a major threat to the Kagu.

Mining damages the landscape, leaving mountain tops with vast areas of exposed laterite (red earth containing iron and aluminium oxides) for all to see. However, most of the areas destroyed as a result of mining are scrubland that are not an important part of the Kagu's habitat. The problem stems from the means of access created to enable humans and machinery to reach the sites. These disrupt entire areas and go hand in hand with yet another important man-made problem: logging. The impact of logging is both direct and indirect. Direct because the destruction of dense canopy trees leads to the destruction of the biotope below, which is so vital to the Kagu. Pines planted as part of reforestation trials all failed and often amplified the initial destruction.

The secondary impacts of mining and logging are even more detrimental to the Kagu. The need for access to the sites means that huge machinery must be brought in to cut tracks through the forest to load and transport the logs and minerals. As a result, all one can see from the summits are deep vertical rock faces. Due to rocks, branches and unwanted tree trunks being discarded and littering the slopes, a huge inextricable mass is created lower down, which is soon covered by dense spiky scrub which, because the Kagu is unable to fly, proves to be an impenetrable barrier to the bird.

An additional and far greater threat comes from the opening of roads, which provide predators with easy access, beginning with vehicles carrying men with weapons, followed by dogs and cats; even seemingly innocent rambblers can cause damage. The Kagu can no longer exist in such areas.

So, at first, a lot of unfortunate Kagus die. Those that manage to escape, often escape into isolated patches of forest, in which they find themselves cut-off from other groups of birds, often also isolated. These geographically isolated populations have no long-term viable future.

Protection of the Kagu

The Kagu is protected both nationally and internationally by the Washington Convention (Annex 1) and the European Convention (Annex A). On New Caledonia, it is, by decree, forbidden to detain or hunt the Kagu. However, this is merely theoretical, as it relies on everybody respecting the rules and regulations. In practice, it is rather different, although hunting appears to have decreased thanks to pressure from the media.

It is not enough to merely have ideas about how best to protect the Kagu, there is a need for the political will and economic support to bring this to fruition. Unfortunately, this is more in the realm of Utopia than of reality. This having been said, what would be the priorities?

Above all, there must be an end to fires which get out of control. We need to explain to those who light these fires that they are not in their best interests and, if this fails, we must ensure that there are the means to quickly bring such fires under control. France must put in place a system to detect and monitor bush fires and there must be trained firefighters and one or two aircraft equipped to drop water on such fires and extinguish them as rapidly as possible.

It will also be necessary to deal with predatory animals, beginning with cats which do so much damage in some areas. Controlling or eradicating feral cats (preferably the latter) must be a major priority, as must controlling or eradicating dogs; poisoning and trapping have been used but in turn create multiple ensuing problems. Rats will also need to be trapped and poisoned.

Feral pig beats are regularly organised, but often are counterproductive. In order to kill a few pigs, dogs are used, some of which escape from the hunters and become killers of Kagus, thereby doing more damage than would have been done by the few pigs that are shot.

One should never forget that the major predator in nature is man, even when he has no ill intentions.

It will be necessary to bring an end to hunting and to train gamekeepers or wardens to enforce the law and apply sanctions. One will have to block plans for further logging, which will destroy native flora and fauna and, eventually, the entire country. Difficult political decisions must be taken; one is aware of the uncertainty in this field and that it depends on so many factors.

The same should apply as far as mining is concerned. However, it is easy to understand the near impossibility of such interdictions, when we know that New Caledonia has 40% of the world reserve of nickel and it is its major source of income.

One can easily understand how extremely difficult it is to bring about such measures, dictated by common sense, but unrealistic on a practical and economic level. What can be just as difficult to do, is to convince those wanting to enjoy a day out in the country, who frequently have the best of intentions, that simply by driving their cars through a nature reserve, they may disturb the Kagus.

Unpopular measures will need to be taken, including closing forest tracks to vehicles and turning them into footpaths and encouraging ecotourism, controlled by the tribes, who would probably gain from this. This may though be wishful thinking and hardly attainable in a country in which intercommunity rivalries are rife.

One must bear in mind that in order to save the Kagu, it is necessary that some survive, perhaps in part, at least, through captive-breeding programmes. For many years, this idea grew and led to Michel Corbassou creating the Parc Zoologique et Forestier (zoological and botanical gardens) 4km (approx. 2½ miles) north-east of Noumea city centre. Many competent and devoted specialists worked on the project from the onset, including Françiox Goix and, Heinrich Bregulla, who instigated its Kagu breeding programme. The zoological and botanical gardens are managed now by Christophe Lambert, a very active and efficient vet. The breeding programme implemented there is the source of the Kagus released into the Rivière Bleue park, on a 9,000 hectares (approx. 22,000 acres) site in the Yaté region in the south of New Caledonia.

For many years, the zoological park owned three pair of Kagus, which were kept isolated from the public in off-show enclosures. The chicks hatched by these pairs were reared by their parents and later transferred to an acclimatisation area, prior to being released into the Rivière Bleue park. The park, which is close to Noumea, is open to the public, who have to pay a modest entrance fee. A small number of civil servants run the park and monitor the ethology (behaviour) of the Kagus. However, even in this protected area, the best intentioned visitors can seriously disrupt the animals while driving along the tourist route through the park. The simple fact that such a road goes through forest that has proved to be favourable Kagu habitat has meant that, confronted with an ever increasing number of cars using the route, most of the birds have fled. At most, all that remain are a few tame Kagus that wander around the feet of visitors to the picnic areas and peck at leftovers. It is evident that the entire policy needs to be

revised and improved.

When one is fortunate enough to have saved the Kagu from extinction, it will remain essential to ensure that it has somewhere safe to live.

At the zoological park at Noumea they have succeeded in raising Kagus, which have been released in the Rivière Bleue park. To round off this success, more nature reserves will be created in the north of the island, at least, this is what we are hoping.

During a study trip to New Caledonia, J. M. Thiollay, a CNRS (Centre National de la Recherche Scientifique (National Centre for Scientific Research)) ornithologist, did some most interesting work and was kind enough to share his findings with us, prior to publication. His field studies highlighted the limited future facing the geographically isolated bird communities cut-off from other groups of Kagus and made a number of recommendations for the long-term conservation of the Kagu on New Caledonia. According to him, only the Rivière Bleue park seems to be large enough to be effective.

In order to protect the future of the species, it is essential to locate further large areas of suitable habitat, not yet occupied by man. Thiollay suggested three sites, where it will, he believes, be feasible to protect both the flora and fauna:

1. Mount Panié, rising to 1,629m (approx. 5,360ft), on the north-east of the island has by far the largest area of forest and the most untouched. It is also the dampest, at the highest altitude and the least known. It seems the perfect site for a northern territory park, which could be the counterpart to the Rivière Bleue park in the south. Its most appealing asset is the complete absence of vehicle tracks, and this must remain so at all costs. Its development must, however, include pedestrian footpaths and small refuges for visitors, the maintenance and patrolling of which would provide jobs for the local people.

2. Thiollay proposed the massif north of Bourail, more or less in the centre of the island, which is still home to wild Kagus, as another highly desirable site for a reserve.

3. Lastly, the Humboldt massif, rising to 1,618m (approx. 5,300ft) in the south, has the advantage of being difficult to access and, its forest, although more fragmented and at a lower altitude, is undisturbed.

At the end of the study it was apparent that the best way to protect the Kagu in particular and, New Caledonia in general, at minimal cost and without changing what already exists, would be to protect what remains intact.

Everywhere man has been, there is damage, most of it irreversible. Therefore, it makes sense to prevent him from destroying what he cannot yet

reach. It is rather disappointing to realise that the salvation of what remains of the New Caledonian paradise and of its iconic bird, rests in the hands of a few individuals and volunteers, isolated from the rest of the world, which remains largely indifferent to its plight.

Systematics and genetics

When one has shared one's life with the Kagu for so many years, one learns that it is no ordinary bird. If one has the curiosity to search the literature which has been dedicated to this bird since its discovery and if one studies the systematics, they teach us that it really is an exceptional bird - but one remains far from knowing the truth about it.

Systematics

The Kagu received its scientific baptism in 1860. Its godparents were J. Verreaux and O. Des Murs, two great French ornithologists of international renown. They baptised it *Rhynochetos jubatus*. *Rhynochetos*, from the Greek *rhinos* (nose) and *chetos* (horn), on account of the exceptionally hard skin that protects its nasal openings; and, *jubatus*, meaning helmet in Latin, on account of its wonderful erectile crest, which when raised looks like a splendid feathered Roman helmet.

Immediately following its baptism, important questions arose as to which bird or birds the Kagu was most closely related to and, over a century later, those questions remain unanswered. Numerous taxonomists have tried to justify incorporating the Kagu into one of the existing families of birds. As early as 1862, Verreaux and Des Murs themselves, indicated that they believed it possessed characteristics which suggested that it could be related to the small, nocturnal, tiger herons *Tigrisoma* spp. of South America. Others talked of it having links with the Sunbittern *Eurypyga helias* of South America, while others suggested possible links with the Mesitornithidae, the three species of rail-like mesites or roatelos living in the forests of Madagascar, that possess fairly long, broad tails and run well but rarely fly. In 1916 the Kagu was thought to be closely related to the Jaçanidae, jaçanas.

One should not underestimate the scientific value of these judgements, but rather deduce that the classification of the Kagu is an extremely complex matter. Many of the species linked with the Kagu come from the famous Gondwana or Gondwanaland, which New Caledonia was obviously part of and where the Kagu spent millions of years. Recently, some researchers even thought that there might be a possible link with the Messelornithidae, fossil birds of North America and Europe.

To sum up this confusing situation, the Kagu is at present placed in the

order Gruiformes - the crane family and its allies - and this for very good reasons. There are, for instance, some anatomical similarities with the cranes. There are also similarities in the colours of their eggs and chicks and, in our opinion, the most striking similarity is in the way in which the colouring evolves through the various stages from chick to adult. The adult Paradise, Blue or Stanley Crane *Anthropoides paradisea*, for instance, sports the same shade of grey-blue plumage as the adult Kagu and, like the Kagu, has a brown coloured chick as well.

Unfortunately, everything remains open to question, even in such a serious domain, because:

The Kagu's nostrils are separated from each other by an osteo-membranous septum (a bony membrane), which is not the case with the cranes.

The Kagu has huge eyes, cranes do not.

The lay-out of the Kagu's feathers is different to that of the cranes.

The Kagu is the only bird in the world that has a operculum (a flap) protecting the nostrils.

Lastly, the Kagu cannot fly, whereas the cranes are capable of flying great distances. One must admit, however, that a few thousand years may have led to this difference.

To sum up, the Kagu is an exceptional being and we believe it would be fully justified to create for it, its own order - Rhynochetiformes - rather than leave it in the poorly defined Gruiformes. However, this proposal is purely my own and commits nobody else and, is perhaps somewhat biased, because I have for over 30 years been a member of its family, by alliance and affection.

Genetics

Genetics provide the precise biological identification of a living being.

Recently we have learned that the Kagu has 82 diploid chromosomes, nearly twice as many as man, who has 46. This figure is called diploid, because it refers to the total number of chromosomes in each cell, half coming from the male and half from the female.

The kariotype is the microscopic anatomical study of the cell nucleus. This study is very important as it shows that in birds there is a net difference in the sex carrying chromosomes. In fact, the male has two identical zz chromosomes and the female has a z chromosome and a w chromosome.

In truth, it is not the study of the chromosomes that will allow us to sex the birds, for it is very complex and subject to visual errors.

Important progress has been made possible by the recent discovery of amplifiers. These allow the nearly infinite multiplication of tiny DNA traces.

It is an important discovery which enables the identification of individuals from what seemed to be invisible traces.

This is the system we use to determine the sex of our Kagus. All that is required is to remove two feathers from the breast - taking great care not to contaminate the quills with our own DNA - and then send them to a specialist laboratory, the best of which is in the UK.

We were at the forefront of work to determine the sex of Kagus using DNA sexing and helped with early research by sending the laboratory feathers from a bird which we knew for certain to be a female and, therefore, carried the ZW chromosomes.

We have been extremely fortunate to enlist the assistance of Bertrand Bed'hom, a bird geneticist in charge of the OVICAP unit at the genetic analysis laboratory specialising in animal species. Bertrand Bed'hom has been kind enough to spare some time from his important scientific research, to provide us with information on the genetics of the Kagu.

To summarize, DNA is a very complex chemical chain, existing in the chromosomes of the nucleus of cells, responsible for passing on the genetic coding of living beings. The ability to sex morphologically identical animals, such as the Kagu, is due to the recent discovery of PCR (polymerase chain reaction) amplifiers, which allow us to multiply indefinitely an infinitesimal quantity of DNA carrying molecules.

It is, therefore, possible to identify a male or a female by isolating the chemical characteristics of the sex chromosome after amplification. These amplifiers, in the same way, allow us to identify a human being, from DNA taken from traces left by his or her contact with an object.

We can in this way determine if the filiations of a subject are compatible with possible parents by comparing the DNA helix, for they are identical only between parents and their offspring. These techniques also allow us to evaluate the genetic diversity of a population in order to reduce the risks of consanguinity (inbreeding), which is especially detrimental in groups of endangered species.

Phylogeny is the study of the genetic links between species in order to establish their genetic heritage through their evolution. Bertrand Bed'hom explained that the few scientific papers dealing with Kagu genetics bring us nothing but uncertainty as to whether or not the Kagu should be regarded as belonging to any specific order.

This brings us back to what we have learned from the important observations on taxonomy made by zoologists since the discovery of the Kagu. For lack of greater precision, it is presently classified in the order Gruiformes, which contains 12 families, one of which is the Gruidae, within which are 15 recognised species of crane. It is placed next to the Eurypygidae

family, whose sole representative is the Sunbittern of tropical Central and South America.

Nobody, therefore, would dare deny that the Kagu is an original and individualistic bird, isolated in the animal world - which is another reason, should we need one, to dedicate ourselves to ensuring its survival.

Bertrand Bed'hom is planning to work with our collection of live birds, the largest in captivity, in an attempt to establish, once and for all, the true origin of the Kagu. To date, what little research that has been carried out has used the DNA, sometimes of poor quality, collected from skins in museums. Here he will be able to collect precise phylogenetic (genealogy) data based on live DNA.

Historical background

New Caledonia was discovered in 1774 by Captain Cook, who landed at Balade on the north-east coast, but did not stay for long and never carried out a full exploration of the island. In one of his reports, Captain Cook mentioned that the region has few animals, which is true. However, his observation that the human inhabitants were friendly, was not quite so accurate, for he was in a dangerous region in which cannibalism was practised. In fact, Cook's stay was very short and this explains his optimistic judgement.

My dear friend Jean-François Cherrier, who was responsible for the Forestry Service in New Caledonia before his premature death in a plane crash on Vanuatu, told me that he had found an interesting drawing dating from the time of Cook's travels, reproduced in George Pisier's book *The Discovery of New Caledonia*. In this drawing, from 1774, by W. Hodges, who sailed with Cook, he thought he recognised a Kagu next to a Kanak hut, and deduced that these birds were domesticated and raised by the inhabitants of the region. However, the bird depicted in the picture could not have been a Kagu, because of its long neck and light ribbon of feathers on the back of the head. As I will explain later, it was in fact a small species of heron.

In 1853, following Entrecasteaux's exploration of the island and its dependencies, France governed by Napoleon III, took possession of New Caledonia. The explorer, who was looking for La Perouse landed, like Cook, at Balade. During the following months Admiral Febvrier des Pointes signed agreements with all the Kanak chiefs.

It was a remarkable period, when Europeans were discovering the world, its human inhabitants and its fauna and flora, with an enthusiasm which was to last throughout the nineteenth century. Boats were carrying scientists and naturalists to the remotest parts of the globe, where they risked their lives gathering for us much of our early knowledge of natural history and ethnology. In 1860, that is to say, within seven years of the Grande Terre (the

main island of New Caledonia) being annexed by France, plants and birds from these far away regions began to reach Europe, having survived many months on sailing ships, followed by a further six weeks on a steamer.

J. Verreaux and O. Des Murs, the two internationally renowned ornithologists, quite often mentioned by John Gould, received the first specimen of a Kagu to reach Europe. The sender was Deplache. The bird, which looked unlike any of those identified to date, was formally described for the first time in the scientific journal *Review et Magasine de Zoologie* in 1860 and baptised *Rhynochetos jubatus*. Neither Verreaux and Des Murs, nor anyone else, however, had a clear idea of which group of birds the Kagu was most closely related to. As I wrote earlier, we have come to the conclusion that, in this matter at least, this question has still not been satisfactorily resolved, even with the help of modern technology.

In 1864, the first live birds were escorted to France by Count de Pouget, Captain of the Fleet. This is what he wrote: "The first Kagus to arrive alive in France were brought in, in 1864, on the frigate I was in command of, the *Sibylle*. They were a male and a female. The male belonged to a marine hand, who was a passenger on board our ship and sold the bird to a Russian amateur, called Divof. The Kagu spent the winter in the Jardin d'Acclimatation (the zoological garden in Paris), and then, was sent to Russia. I do not know what happened to it. Other birds of the species were put on board to journey to France; all died during the crossing. M. Bourquin, Captain of the frigate *Alceste* was bringing two for me. Only the male survived, and is still with me to this date (1870)."

Pouget mentioned that many Kagus were transported to the Île Ouen, a tiny island just off the southern tip of Grande Terre, but all quickly died. Those kept in the garden of the Governor in Noumea suffered a similar fate. Captain Pouget was lucky enough to keep a pair for many years at Rochefort-sur-Mer and made some accurate and relevant observations on the birds, which I look forward to recalling a little later.

In the years following the discovery of the Kagu, many professional and amateur aviculturists attempted to keep it in captivity and raise offspring. It was though a very difficult undertaking, as it is even today, for one is never certain of success when it comes to breeding the Kagu and setbacks are as common as successes.

Edouard Marie mentioned an enthusiast named Mr B. Amstein, based in Noumea, who was raising Kagus, but I have been unable to find further details of this.

The earliest breeding attempts can be summarized as follows:

1904 H. E. Finch, of Sydney, obtained a chick that lived for eight days.

- 1905 In the journal *Emu*, A. J. Campbell described the egg and also a chick that lived for a short time.
- 1919 Listed in the *Avicultural Magazine Index-Guide: 1894-1930* is what seems to have been a near miss breeding the Kagu "By an old Australian Bird-lover," but the page number is incorrect and we have failed to find the correct page.
- 1921 A Kagu chick was raised by its parents in the aviaries of Avicultural Society member G. A. Heumann in New South Wales, Australia.
- 1931 Writing in the *Avicultural Magazine* about the birds at Paignton Zoo in the UK, Hopkinson (1931) mentioned that there were three Kagus, "all cocks" living in a paddock and a further two living in an aviary. A photo of an adult with a small chick was published in the magazine in 1955, as part of the obituary to the zoo's founder and owner Herbert Whitley. Unfortunately, the zoo has no record of which year the chick was hatched or how long it lived - but it could well have been in the early 1930s.
- 1964 In the *Avicultural Magazine*, Klös (1965a & 1965b), described
- 1965 a number of unsuccessful breeding attempts during 1964-1965 at Berlin Zoo, which had imported two pairs in 1962. It seems that the female of one pair laid a total of five eggs, one of which was left with the pair to incubate, with each of the other eggs being placed in an incubator. However, none of the four chicks that were hatched survived more than a few days.

We believe that one or more chicks were hatched at Baltimore, but had not come across any published details. The Hon. Editor contacted Josef Lindholm, who replied that the Baltimore Kagus had a complicated history and that has proved to be true. Fred Beall, General Curator at Franklin Park Zoo in Boston, who was previously Curator of Birds at Baltimore, told Josef that so far as he can recall, the late John Moore, who at the time was Curator of Birds at Baltimore, collected the pair of Kagus and imported the pair into the USA in the late 1960s or early 1970s. While at Baltimore the pair produced many eggs, a few of which hatched but, early on, none of the chicks survived. At some point, John transferred the pair to the Smithsonian National Zoological Park in Washington, DC. There the pair continued to produce eggs and, Fred believes, a chick may have been reared. The fact that, as Fred recalls, Kerry Muller was there at the time, probably puts it between 1965-1969/1970. John Moore later left Baltimore and took the Kagus with him to what was then Salisbury Zoo in Southern Rhodesia (now Zimbabwe). Later, he returned to the USA to become Director of Audubon Park and Zoological Garden, taking with him the pair of Kagus, before

later moving onto Albuquerque Biological Park. Fred Beall is not sure if the Kagus were ever housed at the park, he believes the pair was kept at his home in Albuquerque and heard that "a few more birds were reared." He believes that John Moore died in 2000 or 2001. Neither Fred nor Josef know what became of the birds.

From the discovery of the Kagu in 1860 until the 1980s, quite a few Kagus had been kept in captivity, but almost all breeding attempts had ended in failure - the number of breeding successes could be counted on the fingers of one hand.

The situation changed following the opening by Michel Corbassou of the Parc Zoologique et Forestier (zoological and botanical gardens), about 4km (approx. 2½ miles) north-east of Noumea city centre. Heinrich Bregulla was the first to study the Kagu and organise its breeding in captivity. I have in my hand a letter dated March 8th 1978, sent to me by the Head of the Water and Forestry Service in New Caledonia, with the news that at last they had successfully hatched a Kagu in captivity. He wrote: "The little one is now two months old and appears to be in good health."

Our first chick had hatched here in France two months earlier.

From then on breeding in captivity began to take off at the zoological and botanical gardens at Noumea. Part of the gardens has been divided up into individual enclosures for three breeding pairs, which are kept isolated from public view. The young ones, reared by their parents, are later transferred to the Rivière Bleue nature reserve, at the western end of the artificial Lac de Yaté, a hydroelectric dam. There the young birds are housed in observation enclosures in which they slowly learn to feed themselves. The 9,000 hectares (approx. 22,000 acres) Rivière Bleue park (Parc Provincial de la Rivière Bleue) was created by the government of the southern region, which is also responsible for its maintenance. It is the only place on Grande Terre where the Kagus are relatively safe.

Although it plays an important role, it is, however, open to the public, who can picnic there and also drive through, so is not ideal for the Kagus. Being so close to Noumea it is, of course, easily accessible and the animals are disturbed by cars driving through and are regularly under threat from poachers. One could regret that it is little more than a 'follow on' to the breeding done at the zoological and botanical gardens.

I mentioned earlier that there are other areas of Grande Terre much better adapted to the survival of the Kagu, as they are more isolated from human contact, but they have been left abandoned and are shamefully poached, which brings them closer day by day to zoological and botanical annihilation.

As far as we are concerned, we have been working for more than 30 years

breeding Kagus in captivity, from a time when nothing much was known or in place and, one must say, that a lot still remains to be done.

Having gained the approval of the High Commissioner of the New Caledonia Republic and got a favourable decision from the government, before the country was divided into three regions, we received three pairs of Kagus in 1972. Please believe me when I tell you that all this was not easy. Hostile parties accused us of having the worst of intentions and, as soon as they learned of our success, local people were worried that we were depriving them of their monopoly of the Kagu. Fortunately, more sensible people who knew us well, were aware that we had the best interests of the Kagu at heart and were neither financially motivated nor commercially driven.

We wish to express our gratitude to those who explained to the people of Noumea, that we are not the criminals described in the local newspaper, but selfless environmentalists. I express retrospectively my deepest thanks to my old friend, the late Jean Delacour, with his international reputation, who supported me, nor have I forgotten Mr Eriau, the High Commissioner; Mr Goix, Director of Forests; Mr Bregulla, a specialist on the avifauna of the South Pacific; Mr Audet, civil engineer; Mr Tonnelier, former President of the New Caledonian Ornithologist Society and, finally, the late J. F. Cherrier, Head of the Water and Forestry Service.

In the past 30 years, we have learned a great deal about the Kagu and made a lot of progress in our attempt to ensure its survival.

In the past decade there has been a rise in the number of Kagus being kept in captivity and there have been some encouraging breeding results. Vogelpark Walsrode in Germany received two males in 1997 and a female in 1998, followed by a further female in 1999. During the period 2000-2008, a total of 36 chicks were hatched, of which 20 males and 10 females were successfully reared.

Vogelpark Walsrode breeding results 2001-2008

(courtesy of Zoological Director Simon Bruslund Jensen).

2001	5 chicks hatched	2.1 reared successfully
2002	4 chicks hatched	2.1 reared successfully
2003	9 chicks hatched	4.4 reared successfully
2004	3 chicks hatched	2.1 reared successfully
2005	6 chicks hatched	3.3 reared successfully
2006	2 chicks hatched	2.0 reared successfully
2007	5 chicks hatched	4.1 reared successfully
2008	1 chick hatched	1.0 reared successfully

However, one pair has not laid successfully since 2007 and the sex ratio, which is skewed towards males, is proving to be a serious problem; also several pairs seem prone to destroying their own eggs.

Birds bred at Walsrode have gone to Wuppertal Zoo, Berlin Zoo and a Dr Lehmann in Germany, as well as to Yokohama Breeding and Conservation Center in Japan (where the Kagu is said to now be bred regularly) and the Cracid Breeding and Conservation Center (CBCC) in Belgium, which had its first success in 2008. In addition, a male was reared at San Diego Zoo (Bruslund Jensen pers. comm.). Earlier this year there were six Kagus at San Diego Zoo and one at San Diego Wild Animal Park. Three were hatched at the zoo last year (Lindholm pers. comm.). A fertile egg was laid at Berlin Zoo in 2008, but unfortunately it failed to hatch.

A EEP (European Endangered Species Programme) is to be established for the Kagu. It is a huge step forward and it is hoped that all holders of Kagus will participate in this with as much enthusiasm as this remarkable species deserves. The studbook will be maintained by Luud Geerlings of the CBCC (Bruslund Jensen pers. comm.).

Census of the Kagu population

Exactly how many Kagus remain on the island of New Caledonia and what does the future hold for this species, one of the most endangered birds on the planet?

One can imagine that it is rather difficult to count the number of Kagus, for they are such rare birds and remain hidden beneath the tree canopy in remote forests. Numerous friends living on New Caledonia, who regularly walk in the forests, have never encountered a wild Kagu, nor have the geological engineers prospecting there or those working in the nickel mines. Although New Caledonia appears quite small on a global scale, it covers 16,890sq km (approx. 6,500sq miles) and has at its centre a mountain range with numerous transverse valleys, which can be difficult to access.

I hear you say, but surely the Kagu betrays its presence by its song, which facilitates its identification. After providing a few figures, I will show that this is not so.

Edouard Marie, who took an interest in the Kagu from the moment France took possession of New Caledonia, wrote in 1870 that the Kagu was not too rare and made an excellent dish. The first real attempt to conduct a census of the population was carried out in 1989 by Jean-Marc Thiollay, whom I mentioned earlier. This experienced field ornithologist surveyed the main mountains of the central chain of New Caledonia, guided by knowledgeable local people.

At 31 observation sites, at the right time of the year and under the best possible climatic conditions, he detected the presence of only 17 pairs and five isolated males, doing so by listening to their morning songs. He was unable to investigate all the possible sites, due mainly to the fact that the local

employees, although appointed to monitor the Kagus and who, therefore, should have been able to help, were strangely enough all unavailable to do so during his stay. In short, he found fewer Kagus than he had hoped. He learned that several mountains rich in birds a few years back, had been abandoned by the birds. Out of all the sites thought to be populated by Kagus until recently, Kagus were in fact heard at fewer than 25% of them.

Thiollay estimated that between 100 and a maximum of 300 pairs were still alive and that the world population was, regardless of what was happening in the tourist reserve in the south, steadily declining. As far as he was concerned, the greatest threat to the Kagu is the fragmentation of the forests, caused by logging and the mining of minerals. As a result, small populations of Kagus living in isolated fragments of forest are unable to reach other isolated groups of Kagus, due to their inability to travel across the uneven terrain and make their way through the dense vegetation. Even in the best of cases, if what remains of the forests were later to be rehabilitated, thanks to sufficient remaining trees, the Kagus would not return to them for at least five years.

Later further important research was carried out by Jean François Asmode and published in 1992 in the *Courrier de la Nature*, Issue 133. Asmode studied the results of a two-year campaign financed by the Ministry of the Environment. Observations were made in the area of the mountain chain north of the Rivière Nonda (Nondo River), which was rich in Kagus. This area is the most densely populated apart from the semi-artificial habitat of the Rivière Bleue reserve. Despite this, results were disappointing, with only 109 Kagus, of which there were 45 pairs.

The author pointed out that 40% of the birds counted during this campaign were spread over three wooded areas of modest size. Logging had just begun in one of these areas and plans for further logging were afoot in another, that would drive out the last wild Kagus and they would disappear from these areas.

The most recent census study was published by del Hoyo et al. (1996) and took an overview of the various findings.

Here are the figures:

There was a total of 163 individuals, of which there were 63 pairs in the Rivière Bleue reserve, in the Yaté valley, 60km (approx. 37 miles) from Noumea, which is populated by Kagus raised in captivity at the Parc Zoologique et Forestier, which themselves attract wild Kagus into the reserve.

A total of 491 birds, 208 of which were in pairs, were found on the rest of the mountains of New Caledonia, where the last strictly wild Kagus live.

Overall there were reckoned to be 654 Kagus still living on Grande Terre, the main island of New Caledonia.

The above figures are those obtained in 1996 and are, it should be noted, practically the same as those obtained in 1991. In the *Rare Birds Yearbook 2009*, Hirschfeld (2008) puts the overall population at 250-999 and describes it as stable (Ed.).

The situation is far more worrying than the above figures might lead us to believe. Thiollay argued that it would cost far too much and be of little interest to conduct a new census of the Kagu population, as it would give a false reading, because numerous micro-populations living in segments of fragmented forest are genetically condemned in the long-term. They remain cut-off from other Kagus, and the erroneous impression that there are stable Kagu populations in these areas is due only to the great longevity of the species.

The Rivière Bleue population is, of course, the best known and the only one being monitored, although only partially. As we know, the birds in the reserve come mainly from the Parc Zoologique et Forestier. Before being released they are fitted with radio transmitters, so that their movements can be tracked. If, from time to time their number increases to the extent that some local officials fear the saturation of the reserve, to be honest, we must say that just as often the threat of death hangs over the birds. A while back, in spite of the good work done by Christophe Lambert and his team, the Parc Zoologique et Forestier lost its three breeding pairs, for unknown reasons. This, of course, could happen again and could be catastrophic.

The last surviving wild Kagus still living on the north side of the Rivière Bleue (Blue River) must cope, as best they can, with the encroachment of logging, mining, vehicles and walkers, as well as hunters, dogs, cats and fires and the progressive disappearance of their habitat. The 500 truly wild Kagus living there have been abandoned to their destiny and are trying to survive in a country overtaken and disrupted by man. If nothing is done, it will not be long before they, too, disappear.

I would add a personal word of warning concerning how much confidence can be placed in the song as an accurate means of counting the number of Kagus. We have, up until now, been led to believe that the Kagu has a very distinctive and immutable song, which enables individual birds to be recognised. This belief is without foundation as far as males are concerned.

I have been fortunate enough to enjoy close contact with a great number of males, that I have observed regularly and have noticed that none of them possessed a fixed, uniform and invariable song. Whereas the female's short and sharp song varies very little, even from bird to bird, over a period of

time, males may sing in a completely different way. Of course, an immutable prelude introduces the song and, this is true of all males, but from then on the musical verses can vary. The average musical theme contains 12 notes, but may sometimes contain only 11 or extend to 13, or even 14 notes or more.

So, the number of notes sung by the same male can vary from one day to the next. Just to add to the confusion, at different times during the same recital a male may vary the number of notes he produces. Lastly, some males sing twice a day and sometimes in different rhythms. It is therefore easy to imagine how one might overestimate the size of the Kagu population by relying solely on the song for census purposes.

The Kagu and man

This exceptional bird, first surprised and then won over the scientists, who are still unable to decide on its precise place in phylogenetic systematics.

Jean Delacour's *Guide des Oiseaux de la Nouvelle Calédonie et de ses Dependances*, published in 1966, helped raise the world's consciousness about the plight of the Kagu, at a time when its population was decreasing dangerously and it continued to be hunted regularly for its flesh. Then, in 1985, the IUCN warned us just how much danger it was in, by placing it amongst the world's 12 most endangered birds.

From the end of the Second World War up until recently, the French Overseas Territories Radio Service, which broadcast on New Caledonia, began its programmes with the song of the Kagu and finished with the Marseillaise (the French National Anthem).

Its native New Caledonia, the only place in the world where it can be found, has made the Kagu its own, as a national symbol and emblem. The New Caledonia Post Office has as its symbol a blue Kagu and produces stamps on which it is portrayed in various poses. We also have in our possession stamps from other countries showing the Kagu and, in particular, were surprised to find one printed in Romania.

When one strolls through the pretty town of Noumea, capital of New Caledonia, images of the Kagu are everywhere. Here you are in the Kagu Shop, over there is the Kagu Express and, further on, is the Kagu Boutique. Numerous Kagus are sculpted out of wood, portrayed in paintings and on trays. They adorn key rings, beach bags and T-shirts, and are even made into woolly toys. One can even find beautiful beach towels on which they are depicted in full colour with their wings spread.

I was once told about a craftsman in New Caledonia who had created a clock, the hourly chimes of which corresponded with the number of notes in the Kagu's song. My wife and I searched every single shop in Noumea for such a clock, without success. Then, just before nightfall, as we were

about to give up, we entered a bazaar full of cheap junk and there we found what we had been looking for. Sad to say, our illusion was shattered, for to our immense disappointment it was in fact no more than a plastic Kanak hut, that produced a sound that would have frightened away even the bravest Kagu. For all we know, it may still be there in the bazaar unless, of course, it has been bought by some foolish foreign tourist.

When Captain Cook landed in the Bay of Balade, on the north-eastern coast of New Caledonia, he had sailed only along the east coast of the island and, frustrated by the navigational difficulties he had encountered, preferred to leave for New Zealand, rather than go on to explore the west coast of New Caledonia. As I wrote earlier, some thought that his draughtsman Hodges had depicted a Kagu in front of a Kanak hut, whereas, in fact, the bird depicted is without doubt a Rufous Night Heron *Nycticorax c. caledonicus*, a smaller and differently coloured species. It would have been rather ironic had Captain Cook's expedition, more interested in botany than zoology, seen the Kagu, when the French ornithologist Lesson never encountered one during his many expeditions to New Caledonia.

My wife and I are extremely fortunate to have in our possession two coloured engravings of the Kagu, which were engraved after France first took possession of the island. One is the work of the exceptionally talented zoological illustrator Joseph Wolf and shows two Kagus, one of them with its wings open, as when displaying. I am quite sure that Wolf, who had moved to London and did lots of his drawings at London Zoo, must have seen a live Kagu, possibly the two live examples Dr George Bennett sent to the zoo, which were referred to by Bartlett (1862), or those brought to France by Captain Pouget in 1864. If this was not the case, then the sheer ability of Wolf to imagine the movements of the bird from studying a dead specimen, would mean that his immense talent was even greater than we had been led to believe.

The very interesting little book, *Legendes Canaques* (Kanak Legends), written by G. Baudoux in 1952, tells us about the importance of the Kagu in local war customs. In the north of the island, towards Hienghène, the local name for the Kagu is Kavú. Its feathers, along with tree fern fronds, were used to decorate the handles of obsidian stone axes. Such an object would have been given to the chief of a neighbouring tribe, as a token of their two tribes having joined together in a pact against enemy tribes.

The ritual war dances were accompanied by cries which imitated the song of the Kagu. It was believed that the bird was the ghost of the forest and in possession of magical powers. Baudoux told of an event, which I believe was more historical than legendary. It happened in the not too distant past when cannibalism was still widespread. Kagus, but also humans - first

Kanaks and later Europeans - were eaten up until the time that France took effective measures to bring to an end this loathsome practise.

Baudoux described how one day some warriors surrounded one of their enemies and trapped him in a cave. They thought he would make a good meal, but unable to get to him, they called on the Kagu - the ghost of the forest - or rather a sorcerer dressed as a Kagu. He led them to a crack in the cave wall, through which they were able to smoke out their victim, who they ate with yams (edible tubers) and taro (cultivated in the tropics for its large edible rootstock).

Captain Pouget from Rochefort-sur-mer, who brought the first live Kagus to France, believed that the French name for it, Cagou, should be spelt with a K, i.e. Kagou, as in French some spell Kanaque (instead of Canaque, when referring to the Kanak, the indigenous inhabitants of New Caledonia). In his opinion, to spell it Cagou, was like comparing it with a leper, for whom such terminology applied in the Middle Ages. He also thought that such a spelling would remind us of the cowl of the penitents. As a matter of fact, in central France we have seen penitents' outfits with long pointed cowls, which could remind one of the Kagu's crest, when it is erect. In two regions of France, the Sologne and the Antilles, we were surprised to hear the expression "être cagou" (to be kagu) - meaning tired, exhausted or ill. This terminology obviously dates back to the great plagues of the Middle Ages.

During a great part of my life, I have enjoyed great happiness, being near the Kagus that I have reared. To us they behave like very advanced beings - far from the preconceived ideas many people have of the majority of animals. Some of our Kagus are quiet and reflective and like the music played by man, others are vivacious and cheerful, though sometimes nervous or aggressive, in certain circumstances. As close to man as a child, when being raised, in our company, they will, we are sure, quickly return to their wild state when trained for release.

Some of them used to climb up onto our knees or onto the arm rest of our armchair. I remember the incredible behaviour of one of them, when a TV channel was filming it resting on my knees, when I was sitting in the garden on a summer's day. I was explaining a few facts about the Kagu and, as I pointed to its wings and explained about their wonderful mobility and striking coloration, my friend spontaneously spread its wings and showed them off, to the great delight of the TV cameraman and the contented father I felt like on that particular occasion.

During the filming, which stretched over a period of time, a powerful male attacked a cameraman it had taken a dislike to. With its beak, it gripped hold of the man's foot, spread its wings flat against the ground and refused to move. I had to intervene to free the man, who came out of it with a deep

split in his shoe and a nice bruise on his foot.

I would like to return to Captain Pouget, who brought back to Europe the first live Kagus and kept a pair of them at his home, to brighten up his life after he retired from the sea. He was one of the first men to discover the Kagu and appreciate it in captivity. In 1875, he wrote in the journal of the Société d'Acclimatation: "I have in my possession two Kagus; male and female. It is very difficult to generalise on the behaviour and character of the whole species from these two specimens because, as much as the female is friendly, sociable, soft and greets people, even strangers; the male is wild, hiding in the remotest corners and sometimes running away as if he were mad.

The only creature he has befriended is a small terrier bitch, and when we are unable to find him at bedtime, we are sure to find him asleep next to his friend in the kennel.

On the contrary, as soon as the female hears the garden gate opening, she runs to welcome the visitor and do her prettiest curtsy for a petting.

Quite often during the summer, a few of us are gathered in the garden; then the female Kagu comes and places herself in the centre of our circle and shows off by letting her wings fall half opened, in the shape of a crinoline, and begs for a petting from each and every one of us, imitating a waltz step, and, from time to time, giving a small back kick with her feet, as if to rearrange the folds of her crinoline.

However, one must be careful while petting her, for, if we are not paying her enough attention, she gets impatient and starts pecking, at first quite innocuously. If one does not pay much attention to it, she will withdraw. If one shows fear, she will be more forceful. If one threatens her with a cane, then she counterattacks and would rather die than give up, so we are forced to carry her away. I am the only one allowed to tell her off and even to pretend beating her without risk of retaliation."

I have quoted Captain Pouget's words written more than 130 years ago, because he described perfectly what I have experienced every day for a third of a century.

I cannot resist quoting yet a further extract from Pouget, who too loved the Kagu with passion. He wrote: "In the winter, sometimes during lunch, I would let them come near me, putting two stools near the fire; each of them would grab theirs and start warming up. It was easy to make them sing at will. Should they hear a barrel organ passing in the street, or chords from a piano, they would both start singing as one. They also sing if a clear voice gives them a note. So, every time I receive visitors, we make them sing for everyone's delight."

Pouget gave yet more evidence of his fondness for them, writing: "Mr Pianet, the owner of a magnificent menagerie was in rapture in front of my

Kagus; he offered me 10,000 francs (more than €30,000 or £20,000), but I could not bear parting with my dear friends.”

It has to be said that the Kagu has never left a human being indifferent and, Count de Pouget before me, just as much as me, has had real affection for them.

Captivity and reintroduction

Everybody agrees that freedom is preferable to captivity. Some so-called conservation societies and other such organisations campaigning for the protection of the environment have based their very existence on this principle, in order to fight against saving animals through keeping and breeding them in captivity. However, before fighting the concept of keeping any animal in captivity, using ill-placed sensitivity and morality, one should be honest enough to consider the problem as a whole, when the final goal is the reintroduction of species of animal back into the wild.

To reintroduce animals back into the wild, it is first necessary to have some at your disposal. To have them, they must be reared in captivity, if nature can no longer manage to do so.

If we agree with the opponents of keeping and breeding animals in captivity that freedom is, of course, the better option, they ought at least to meet us halfway and recognise that an animal is still better off in a specialised environment adapted to its needs, be it in captivity, than to end up as a specimen in a museum. For this is the reality. Before considering any other methods though, we should, of course, promote its survival *in situ* by any appropriate means, but if it is no longer possible, then it is essential to resort to saving animals by using captivity as a temporary measure starting, of course, with the most urgent cases.

Over the course of nearly 40 years I have created what I am proud to consider a genetic vault containing species of animals at the top of the endangered list, which have been entrusted to me by governments of various countries, one of them being New Caledonia, with the Kagu. In 30 years we have created the largest group of captive Kagus in the world, that now consists of over 50 adults. The advantage of this is that it allows us to create a genetic pool which would have the specific characteristics vital to the future of the wild population.

However, one must recognise that the reintroduction of a species back into the wild usually means many problems must first be solved and a vast sum of money is likely to be required. On Grande Terre, the main island of New Caledonia, to which the Kagu is restricted, we have the huge advantage of areas of native flora that remain relatively unspoilt and wild, so we do not have to replant forests with trees and wait 25-50 years for them to grow. It

will, however, be necessary to deal with the many dangers threatening the Kagu and its habitat. This is easier said than done.

If our devout wish was to be answered, we would, for example, have to create corridors to reunite the small groups of Kagus which have become isolated from each other due to the fragmentation of their habitat, brought about by the logging industry. We would also have to reintroduce birds bred in captivity and would have to address the imprinting of captive-bred Kagus. We have taken a long and hard look at this and found, to our surprise, that it can be overcome. We believe that if birds are isolated in a quiet wooded area and fed without being able to see their carers, then made to hunt for their own food, within a few months they will become wild again.

Naturally, we do not spend our time training our Kagus to be wild, as it would upset us, but we know that if the time comes for their release, they will survive without us. They might miss us as much as we would miss them. One must rejoice in the fact that Kagus reared in the Parc Zoologique et Forestier have been released in the Rivière Bleue reserve. However, this is sadly, the only place in New Caledonia where it has happened. The Rivière Bleue reserve which is home to the only protected Kagus on New Caledonia stretches over 9,000 hectares (approx. 22,000 acres); I hardly dare mention that Grande Terre, the main island, covers 2,000,000 hectares (approx. 247,000,000 acres). To attempt to restock such a huge area, we will have to bring in birds from various outside sources to augment those bred at the Parc Zoologique et Forestier breeding station. This will be when the real difficulties begin, for we will need keepers, army personnel, firemen, planes equipped to extinguish forest fires, strictly enforced laws to put a stop to deforestation and there will need to be regular culls of cats, dogs, pigs and rats. We are talking about feats that would have discouraged Hercules.

If, as seems likely, this proves not to be possible to implement, we may have to drop a bombshell by asking the following question: if New Caledonia does not have the means to maintain its Kagu population alive outside the Rivière Bleue reserve, should we not try to find another suitable site elsewhere in the world? Maybe in a suitable region of France or one of its overseas territories offering acceptable geographical and climatic conditions for the survival of this bird, which is presently more threatened than it is protected.

Having listed the considerable amount of work necessary to try to save the Kagu from extinction, we must think hard and long and try to analyse the many obstacles that will need to be overcome. All of the dangers mentioned so far have a common denominator - man. Therefore all of those working towards the conservation of threatened and endangered species must concentrate on him. It is essential to inform and educate the perpetrator about

wildlife conservation from an early age. Once a child has passed 10-12 years of age, it is already too late and, by then, one must rely on sanctions and restrictions, which are often difficult to enforce, as it is impossible to have a police officer watching over each individual.

So, what are we to do? A few years ago I created two associations, CAVEX (Conservatoire des Animaux en Voie d'Extinction), the Conservatory for Endangered Species and ASSA (Association pour le Sauvetage et la Sauvegarde des Animaux), the Association for Saving and Safeguarding Animals. The aims of these associations are to educate children about protecting wildlife, to prevent the adults they will become from cutting off the branch on which they sit so precariously.

We selected three major ways to protect endangered species:

1. Ensure their survival through captive breeding programmes.
2. Reintroducing the species back into the wild, which is of course, the aim of most, if not all, captive breeding programmes.
3. Finally, and above all, train children to safeguard wildlife, so that they become ecocitizens, who are prepared to protect wildlife rather than destroy it through sheer ignorance, indifference or cowardice.

We are privileged to have the support of major French institutions, including the Paris Natural History Museum, Alfort National Veterinary School, Pasteur Institute, National Society for the Protection of Nature, the Environment Ministry and French Institute. We are, as well, extremely fortunate to have UNESCO as a sponsor.

Our educational activities have been developed in conjunction with the French national education system, under the watchful eye of ASSA, our ethics and scientific committee. Working with local authorities and the French national education body, we welcome thousands of school children accompanied by their teachers to the Conservatoire des Animaux en Voie d'Extinction. We provide the children with educational material appropriate to their age and by showing them living examples of species that are threatened with extinction, we teach them to love and protect wildlife, by taking an interest in it through play.

We familiarise them with ideas of protection, without forcing them to learn anything too daunting. They play, take photographs, draw pictures and do role play on animal themes. Monsieur de La Fontaine, the author of French morality fables using animals as interpreters, is one of the best allies of our educational programmes.

Our free exhibitions are seen by thousands of visitors and help educate them about endangered species. The Kagu, like many other endangered animals, always fascinates children when they discover it. These events

will, I hope, make today's children the staunch defenders of all endangered animals.

I will have achieved my goal when children understand that saving endangered wildlife begins with understanding it and loving it. In order for them to lead the rebirth of our troubled world, they will need to remember that people before them and, for them, have dedicated their lives to protecting the environment.

I will conclude by recalling the wonderfully prophetic words of my dear friend Jean Delacour, who days before his death in 1985, wrote:

"Since time immemorial, whenever everything seemed lost, there has always been a small number of men able to save what could still be saved and pass on the seeds of the rebirth of civilisation to future generations."

We should never forget this.

Product mentioned in the text

Buddy Egg Monitor: Avitronics, PO. Box 107, Truro, Cornwall TR1 2YR, UK. E-mail:info@avitronics.co.uk/Website: www.avitronics.co.uk

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PLANNED VISIT TO BELGIUM

The society is planning a trip to Belgium over the weekend of October 2nd-October 5th to visit Parc Paradisio and a Belgian private collection. The group will travel there on the evening of Friday, October 2nd. There will be a number of pick-up points, including at Westbury, Fleet Services on the M3, Cobham, Surrey and Medway Motorway Services on the M2, before travelling on via Folkestone and Calais.

The visits to Parc Paradisio and the private collection will take place on Saturday, October 3rd and Sunday, October 4th. The group will leave Belgium on Monday, October 5th and travel back to England via Dunkerque, Calais and Folkestone. The final drop-off point will be Westbury.

Further information is available from: Howard Travel, 12/13 Church Walk, Trowbridge, Wiltshire BA14 8DX. Tel: 01225 777227/
E-mail: karli@howardtravel.com



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*An English translation by Soazig Le Nen Davy and Ghislaine Coulon of
an extract from Dr Quinque's forthcoming book Sur la piste des animaux
en danger (On the trail of endangered animals).*